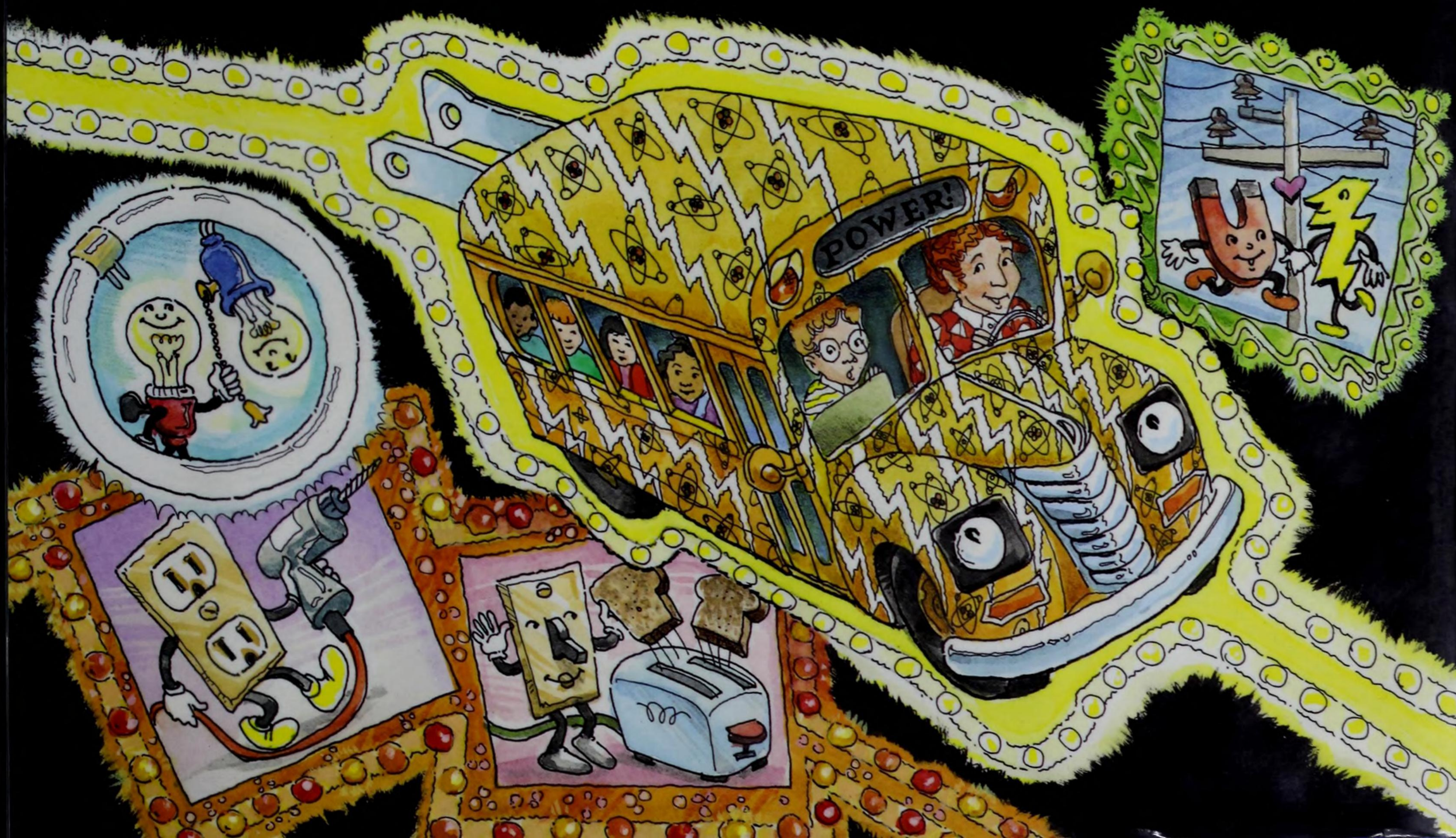
JOANNA COLE & BRUCE DEGEN

The Magic School Bus and the Electric Field Trip



$15.95
Higher in Canada

What is electricity?

How is it made? In Ms. Frizzle's class, there's just one way to find out — a field trip on the Magic School Bus! After experiencing firsthand how a power plant makes electricity, the kids shrink small enough to squeeze through the power lines. They learn how electric current travels through the town, and how it lights up a light bulb, heats up a toaster, and runs an electric motor.

Fans of the Magic School Bus won't be left behind by this simple and informative introduction to the generation and distribution of electricity. It's the most energizing field trip ever!

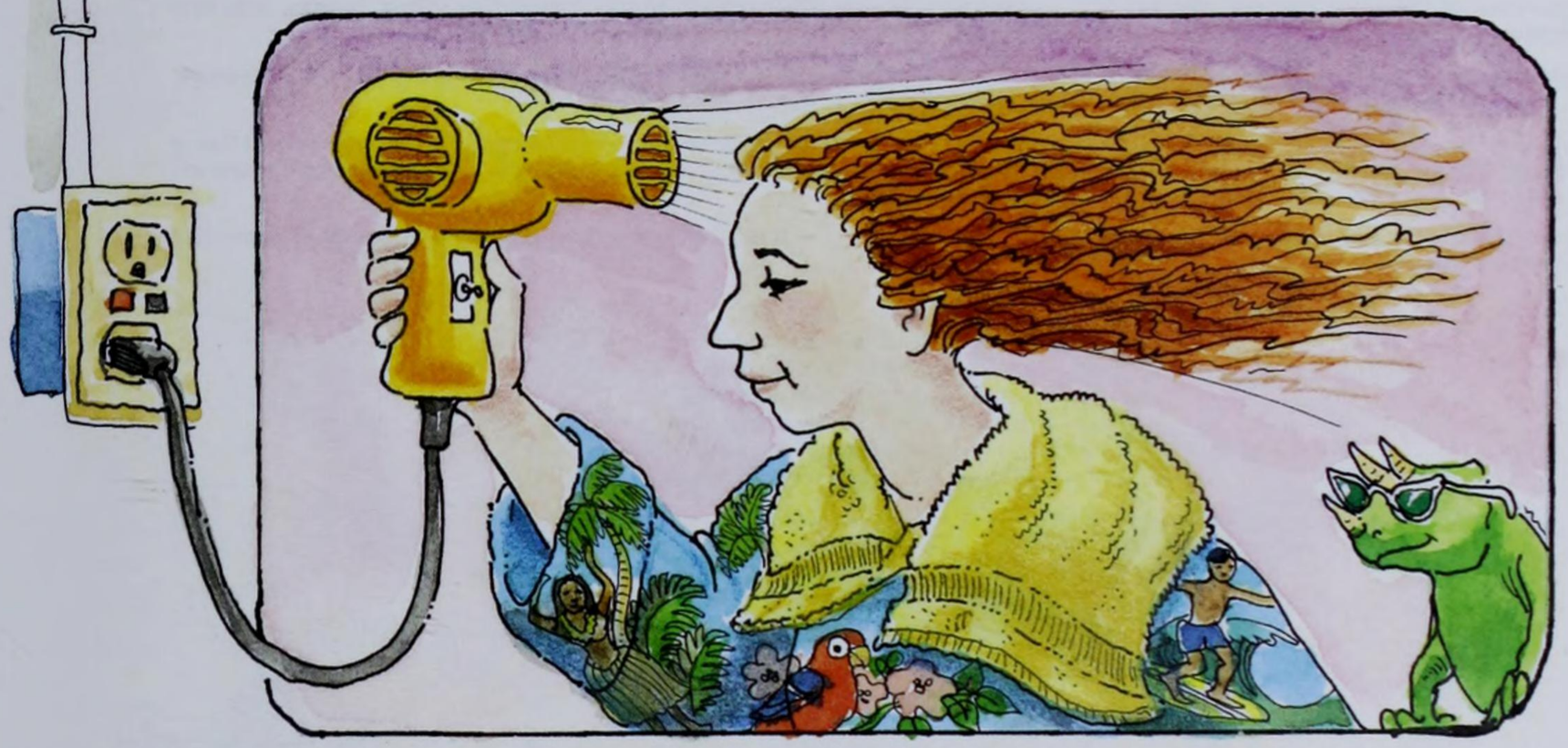
SCHOLASTIC PRESS
555 Broadway, New York, New York 10012

The Magic School Bus

and the Electric Field Trip

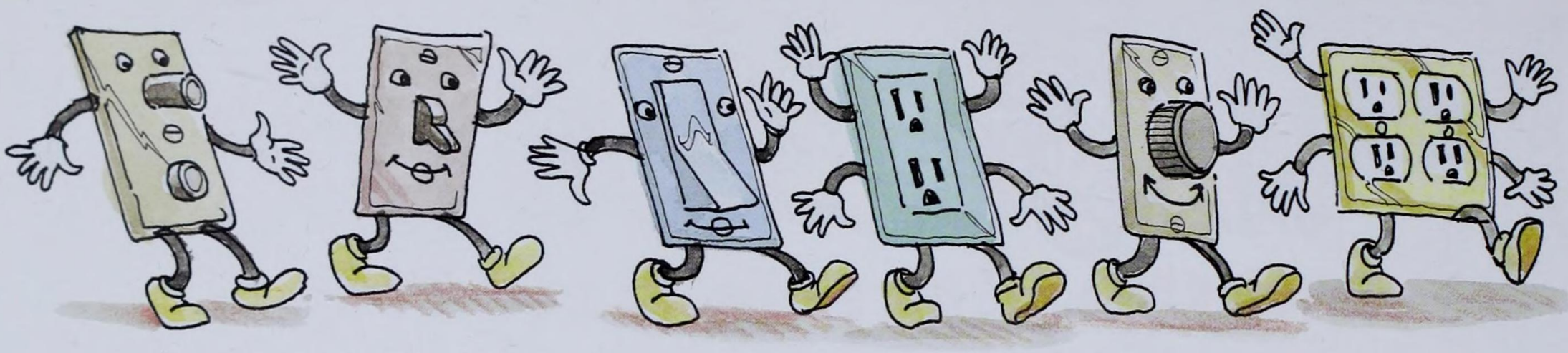
WALKERVILLE
POWER
CO.

The Magic School Bus
and the Electric Field Trip



By Joanna Cole
Illustrated by Bruce Degen

Scholastic Press / New York



For their careful reading of the manuscript and sketches, we thank Mark Reed, Professor of Electrical Engineering and Applied Physics, and Chairman of Electrical Engineering, Yale University, New Haven, Connecticut; Robert Von Achen, Team Leader, Millstone Information and Science Center; and Michael Templeton, Science Content Director, Magic School Bus television series.

The author thanks Bruce Rideout for lengthy discussions about alternating current, and Vin Licursi for sharing his expertise on electric motors. A big thank you goes to Stephanie Calmenson for her indispensable insights and enthusiasm.

Lauren Thompson, our editor at Scholastic, experimented tirelessly with the mini-generator shown on page 12, and found out that it will not light a light. She also discovered that a moving compass needle does not prove that current is flowing. Michael Templeton helped us decide how to build the final device, for which we are very grateful.

The illustrator thanks Bill Stax, Cheryl Duey, Charlie Chapin, Ray Plue, and Kathy Britt for showing him all about electricity at Connecticut Light and Power.

Text copyright © 1997 by Joanna Cole
Illustrations copyright © 1997 by Bruce Degen
All rights reserved. Published by Scholastic Press,
a division of Scholastic Inc., *Publishers since 1920.*
THE MAGIC SCHOOL BUS, SCHOLASTIC, and SCHOLASTIC PRESS and associated logos
are trademarks and/or registered trademarks of Scholastic Inc.

No part of this publication may be reproduced, or stored in a retrieval system,
or transmitted in any form or by any means, electronic, mechanical, photocopying,
recording, or otherwise, without written permission of the publisher.
For information regarding permission, write to Scholastic Inc.,
Attention: Permissions Department, 555 Broadway, New York, NY 10012.

Library of Congress Cataloging-in-Publication Data
Cole, Joanna.
The Magic School Bus and the Electric Field Trip/by Joanna Cole;
Illustrated by Bruce Degen.
p. cm.
Summary: Ms. Frizzle takes her class on a field trip
through the town's electrical wires so they can learn
how electricity is generated and how it is used.
ISBN 0-590-44682-7
1. Electric power — Juvenile literature. 2. Electric power distribution — Juvenile literature.
[1. Electricity. 2. Electric power.] I. Degen, Bruce, ill. II. Title.
TK148.c57 1997
621.3—dc21 97-2080
CIP AC

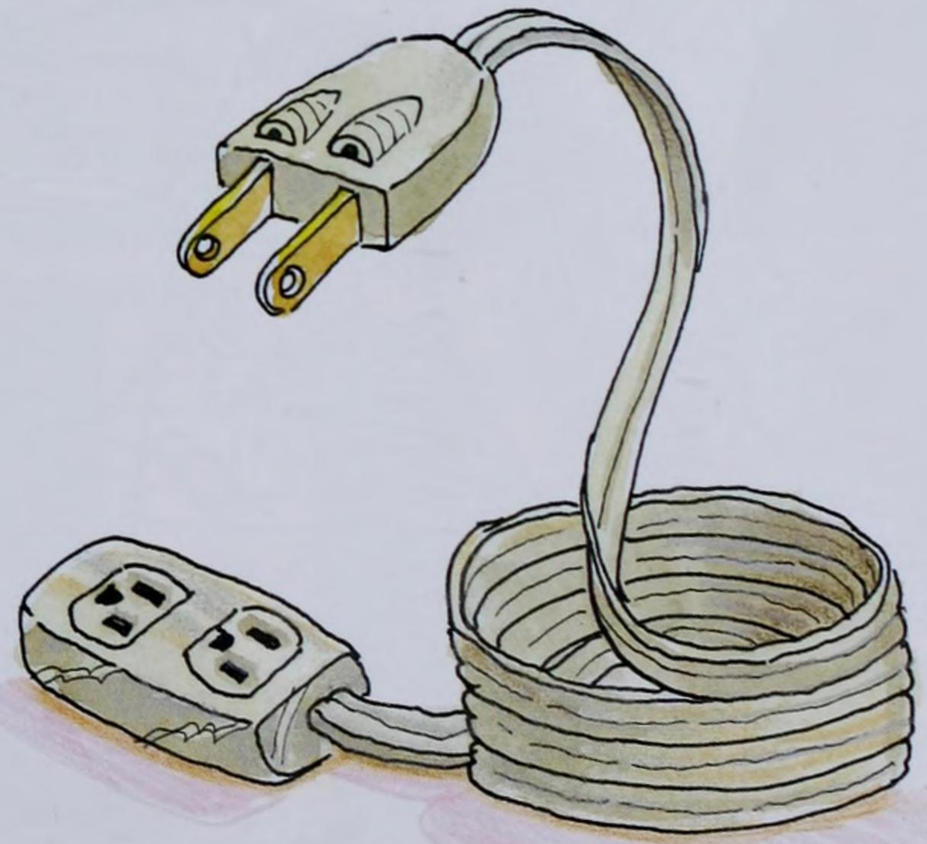
2 4 6 8 10 9 7 5 3 1

Printed in the U.S.A. 37
First edition, October 1997

The text type was set in 15 point Bookman Light.
The illustrator used pen and ink, watercolor, color pencil,
and gouache for the paintings in this book.

To Rachel—Watt a gal! **J. C.**

To Trevor and Garrett and all the Roses,
especially Matt, who opened my line
to the electric company. **B. D.**



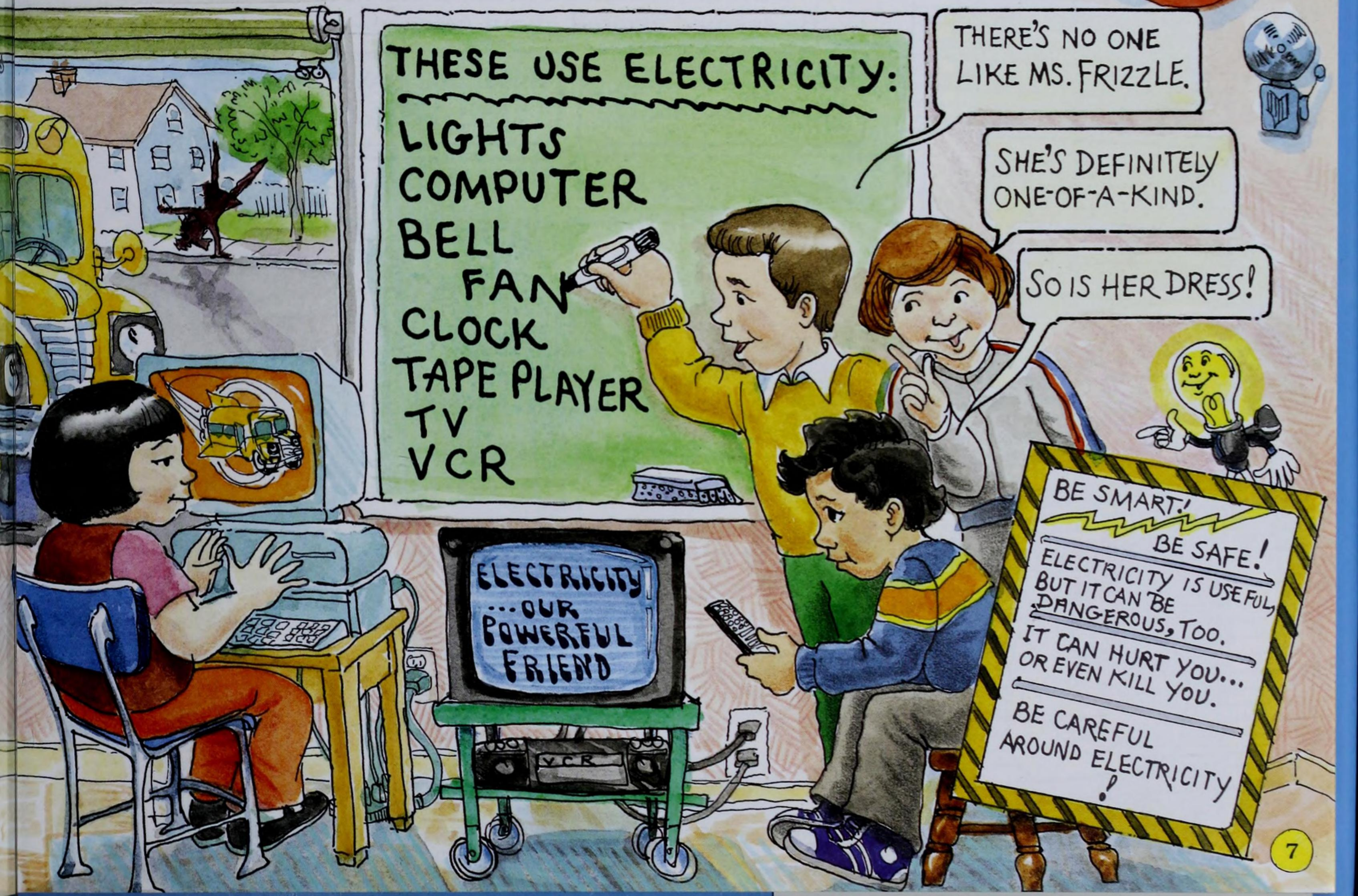
It looked like rain on the day Ms. Frizzle decided to teach our class about electricity. She gave us books, she showed us videos, and she helped us do experiments. As usual, the Friz was excited about science.

ELECTRICITY CAN DO WORK!
by Keesha
It can make things:
--Glow with light
--Heat up
--Move

CLASS, ELECTRICITY IS ONE OF THE STRONGEST FORCES IN OUR LIVES.

MS. FRIZZLE IS THE STRONGEST FORCE IN MY LIFE.

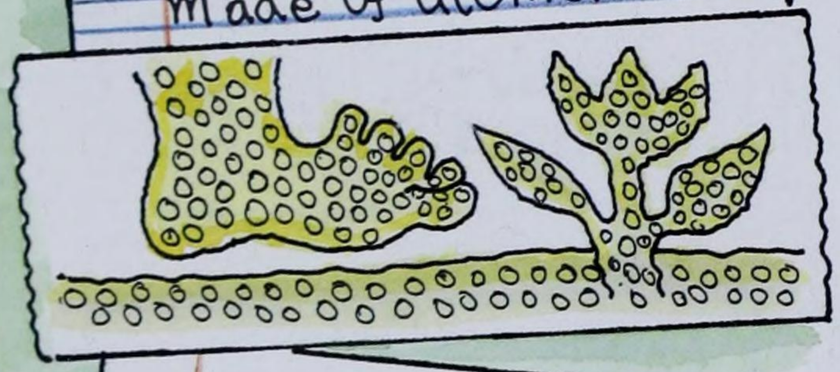
Every once in a while, Ms. Frizzle looked out the window and murmured to herself, "She should be here any minute."
"*Who* should be here?" we wondered, as we made a list of everything in our classroom that uses electricity.



EVERYTHING IS MADE OF ATOMS

by Arnold

The air you are breathing... the book you are reading... the floor under your feet... even your own body — all of these are made of atoms.



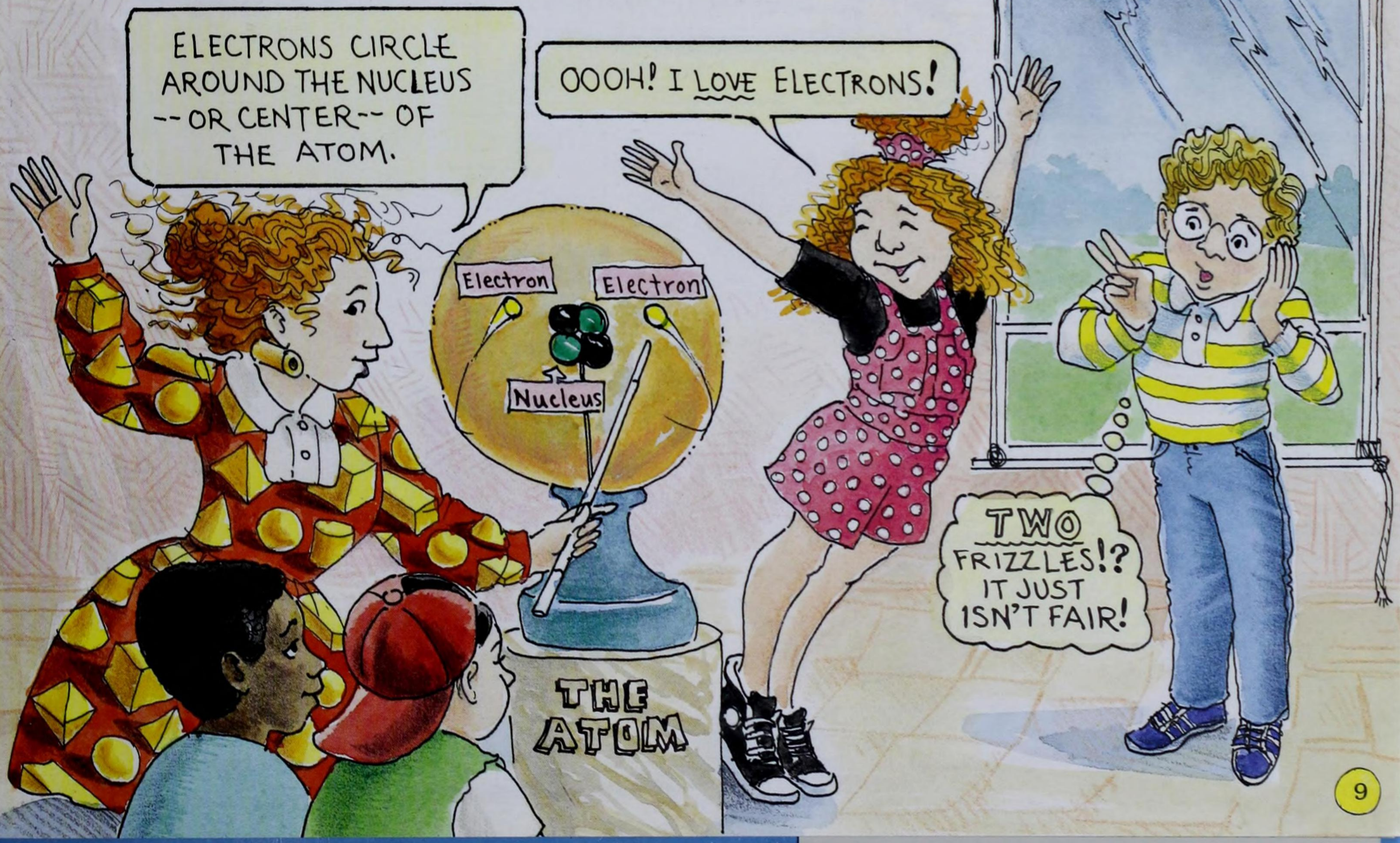
ATOMS ARE VERY, VERY, VERY, VERY SMALL!

by Wanda

It would take more than a million atoms to stretch across the width of just one human hair.

Just then, a red-haired girl cartwheeled into the room.
"Hello, Aunt Valerie," said the girl, kissing Ms. Frizzle on the cheek.
"My niece, Dottie Frizzle, is visiting today," said the Friz.
"Dottie, we're learning about electricity!"
Dottie seemed excited about science — just like the Friz.

Ms. Frizzle took out a pointer and said, "Class,
to understand electricity, we must understand atoms.
Here is a giant model of an atom."
She pointed to the outer part of the atom model.
"These tiny parts of the atom are called electrons,"
she said.

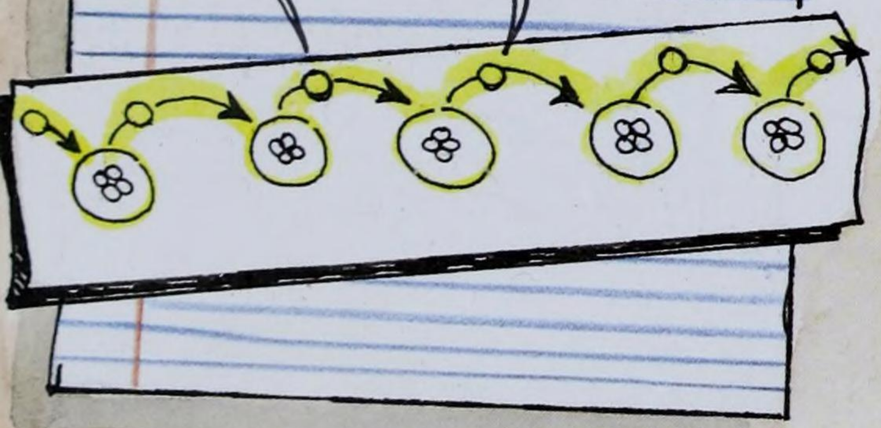


"Most of the time, electrons stay with their own atom," continued the Friz.
"But sometimes electrons get pulled away.
They leave one atom and jump to the next.
They make a stream that runs from atom to atom.
This stream is called electric current."

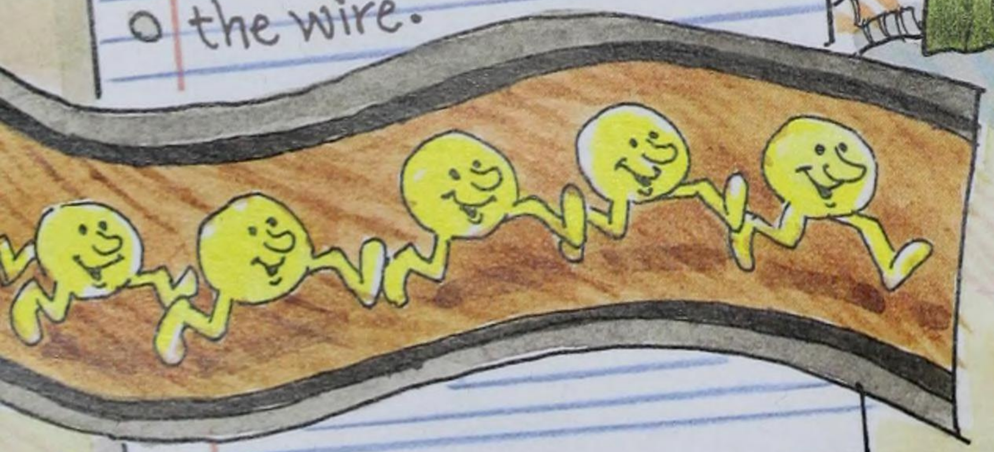
TRAVELING ELECTRONS ARE ELECTRICITY
by Michael

WHEN WE TRAVEL...

...YOU GET POWER!



A WORD FROM DOROTHY ANN
Current comes from a word that means "to run."
Electrons run through the wire.



ELECTRIC CURRENT RUNS FROM THE WALL OUTLET THROUGH THE PLUG...

THROUGH THE WIRE... AND INTO THE FAN'S MOTOR...

AND THAT'S WHAT MAKES IT WORK!

Outside, the sky got darker and darker by the minute, and big raindrops started plopping down.
Ms. Frizzle picked up a roll of electrical wire.
"I am peeling off some of the plastic insulation to show you the copper wire inside," she said.

THE METAL WIRE MAKES A PATH FOR THE ELECTRONS. THE PLASTIC COVERING KEEPS THEM IN THE WIRE-- AND AWAY FROM US.
WOW! IT'S A SUPER-HIGHWAY FOR ELECTRONS!

SOME MATERIALS ARE GOOD PATHS by Carlos

Current runs through some materials easily. Why? Because their electrons are loosely bound. They travel easily from atom to atom.

Some good paths:
Metals Acids
Water

OTHER MATERIALS ARE GOOD BLOCKERS

In some other materials the electrons are tightly bound. It's hard for them to run. Good blockers make good insulators.

Some good blockers:
Plastic Rubber
Wood Glass Air

MAKING A MINI-POWER PLANT

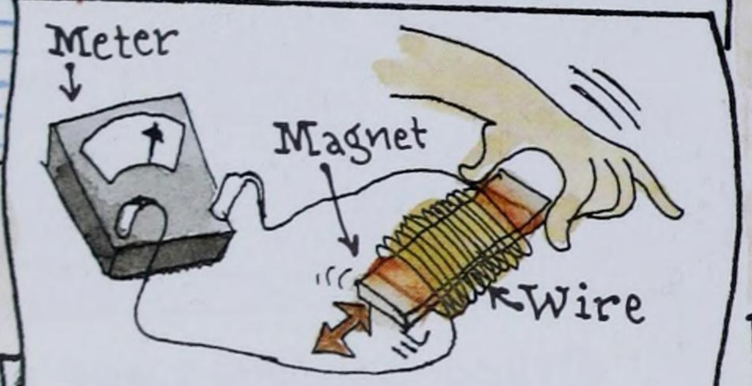
by Ralphie

What we use:

--6 feet of thin copper wire
--Bar magnet
--Meter to measure current

What we do:

--Wrap wire into coil (400 turns)
--Attach wire ends to meter
--Move magnet inside coil



What happens:

--The meter needle moves!

Why it happens:

--Moving the magnet makes current flow in the wire.
--Current makes the needle move.

Frizzie said that one way to make electric current is to move a magnet near a wire.
We made a tiny power plant in our classroom.
We were making electric current!
Our mini-power plant can move one little needle.
But the city power plant sends enough electricity for our whole town.

YOU MEAN JUST MOVING A MAGNET NEAR A WIRE MAKES ELECTRONS TRAVEL?
YES, RALPHIE, BUT WE MUST HAVE AN UNBROKEN CIRCUIT --CIRCLE--OF WIRE.
IF THE CIRCUIT IS BROKEN, THE NEEDLE WON'T MOVE.

Just then, lightning flashed and thunder cracked outside.
The lights in our room flickered and went out.
All the appliances stopped running.
"There's no electricity!" someone yelped.
"We're experiencing a blackout," said the Friz.
"Let's find out what happened."

LIGHTS OUT!
by Gregory
A blackout happens when electric current stops flowing from the power plant to the community.

WE'RE NOT GOING TO STAY HERE IN THE DARK, ARE WE?

TO THE BUS EVERYONE!

OOOH! I LOVE BUSES!

Q: WHAT IS LIGHTNING?
A: IT IS ELECTRICITY!
by Phoebe
When a storm happens, extra electrons stick to tiny drops of water or ice.
When enough of them gather together in one place, they jump.
This is a bolt of lightning!

Soon we were riding on the old school bus, trying to find out what had caused the blackout. It wasn't long before we saw the problem. The lightning had hit a tree and knocked it down. The falling tree had broken a power line. Sparks were flying everywhere.

ELECTRONS CAN'T RUN TO OUR SCHOOL BECAUSE THE PATHWAY IS BROKEN.

WOW!

WHERE ARE THOSE ELECTRONS WHEN YOU NEED THEM?

LIGHTNING SAFETY RULES

DURING A LIGHTNING STORM:

--DO NOT STAY OUTDOORS.
GO INTO A HOUSE, CAR, OR BUS.

--DO NOT USE THE TELEPHONE.

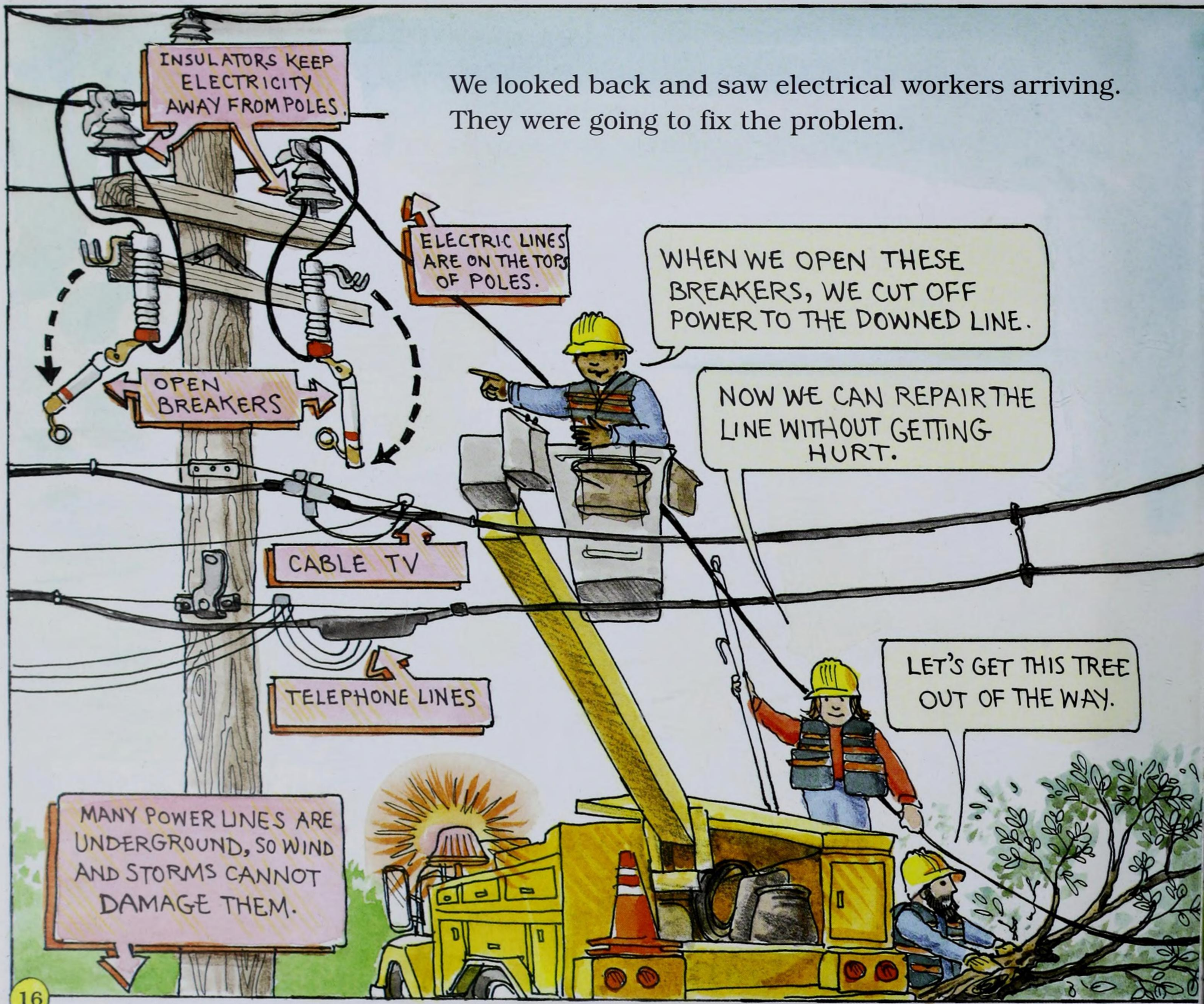
--DO NOT USE ELECTRIC APPLIANCES.

--DO NOT GO NEAR WATER.

"Help! Let's get out of here!" we yelled.
The Friz didn't waste a minute.
She made a U-turn and drove away.

IT'S SMART TO BE AFRAID OF A DOWNED POWER LINE, CHILDREN.
I MUST BE EXTRA SMART!
BE SMART BE SAFE
STAY AWAY FROM A DOWNED POWER LINE. IT COULD KILL YOU!

We looked back and saw electrical workers arriving. They were going to fix the problem.


INSULATORS KEEP ELECTRICITY AWAY FROM POLES.
ELECTRIC LINES ARE ON THE TOPS OF POLES.
WHEN WE OPEN THESE BREAKERS, WE CUT OFF POWER TO THE DOWNED LINE.
OPEN BREAKERS
NOW WE CAN REPAIR THE LINE WITHOUT GETTING HURT.
CABLE TV
TELEPHONE LINES
LET'S GET THIS TREE OUT OF THE WAY.
MANY POWER LINES ARE UNDERGROUND, SO WIND AND STORMS CANNOT DAMAGE THEM.

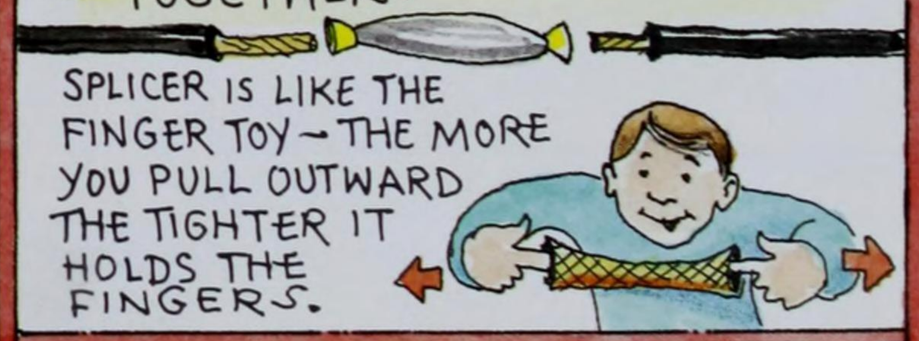
Up ahead was the town's power plant.
It looked like a little city of buildings.
"Inside those buildings is the equipment that makes electricity, class," Ms. Frizzle told us.
"Oooh, let's visit the power plant now," suggested Ms. Frizzle's niece.
"What a wonderful idea, Dottie!" crowed the Friz.
"Hang on, everyone!"

HOW WE FIX A BROKEN LINE

1. AFTER WE ARE SURE ALL THE BREAKERS ARE OPEN, WE CAN BEGIN WORK.

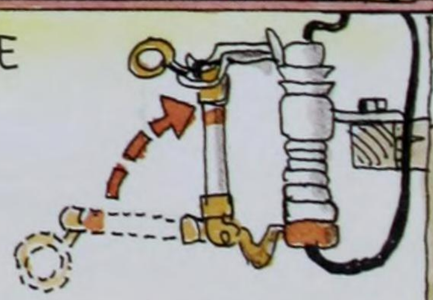
2. THEN WE PULL THE BROKEN ENDS TOGETHER.

3. NEXT WE SPLICE THE WIRES TOGETHER.



4. WE PUT THE LINE BACK UP.

5. WE CLOSE THE BREAKERS AGAIN.



6. WE'RE DONE! ON TO THE NEXT JOB.

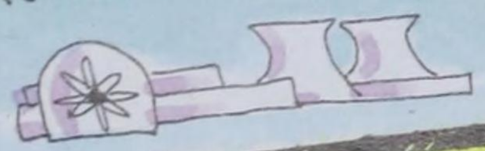
POWER PLANTS ARE HOT STUFF!
by John

Most power plants use heat to make electricity. They burn fuels such as coal, oil, or natural gas.

THE GOOD NEWS:
Fuel-burning plants can make huge amounts of power.

THE BAD NEWS:
They all make air pollution.

Some plants get heat from nuclear reactors.

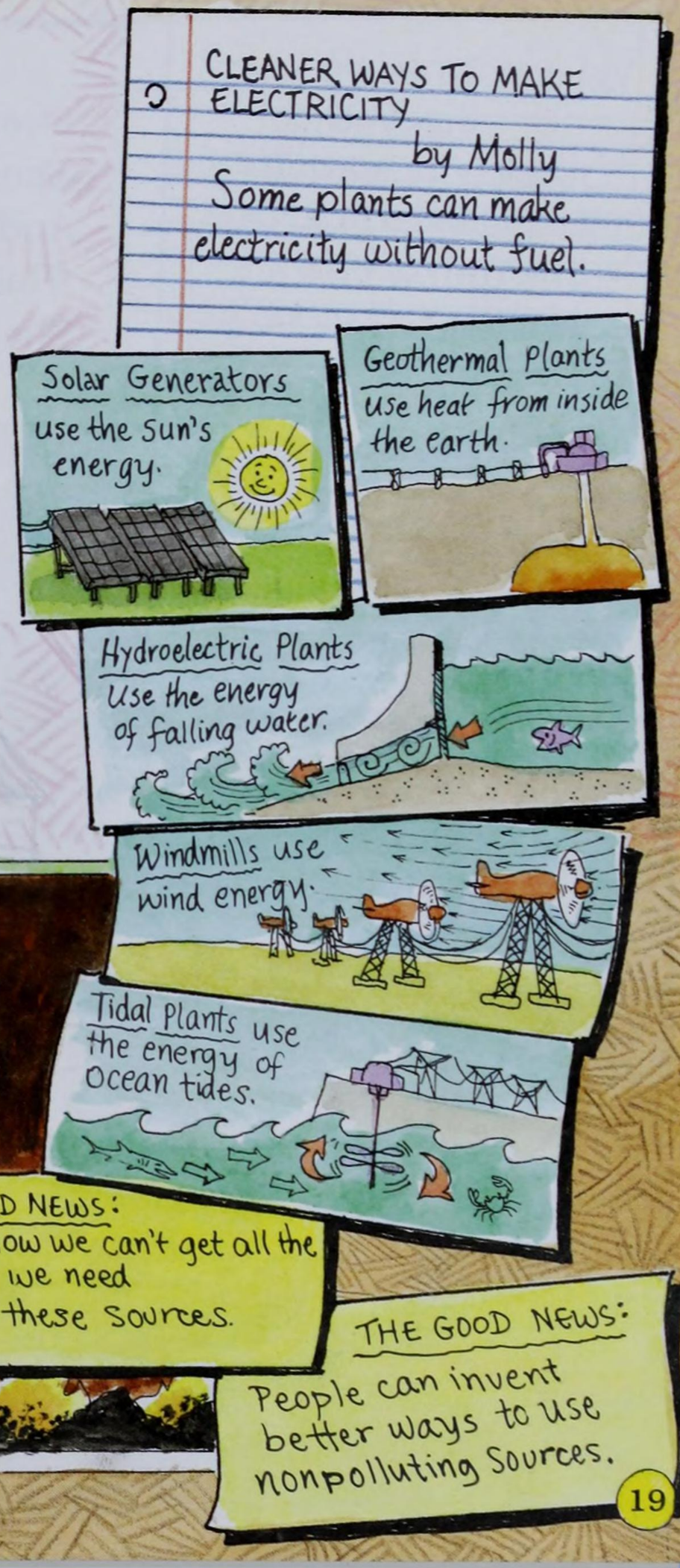


THE GOOD NEWS:
These make huge amounts of power without air pollution.

THE BAD NEWS:
They create nuclear wastes.

When we arrived at the plant, Ms. Frizzle gave us heat-proof suits and said, "We'll begin our tour by observing the fuel supply." She pushed a little button on the dashboard, and the bus changed into a dump truck. "Making a delivery!" Ms. Frizzle yelled.

The dump truck tipped up, and
we went tumbling down the coal chute.
We landed in the coal bin and slid
right into a furnace of flames.
"Let's see what all this heat is used for,"
said Ms. Frizzle.

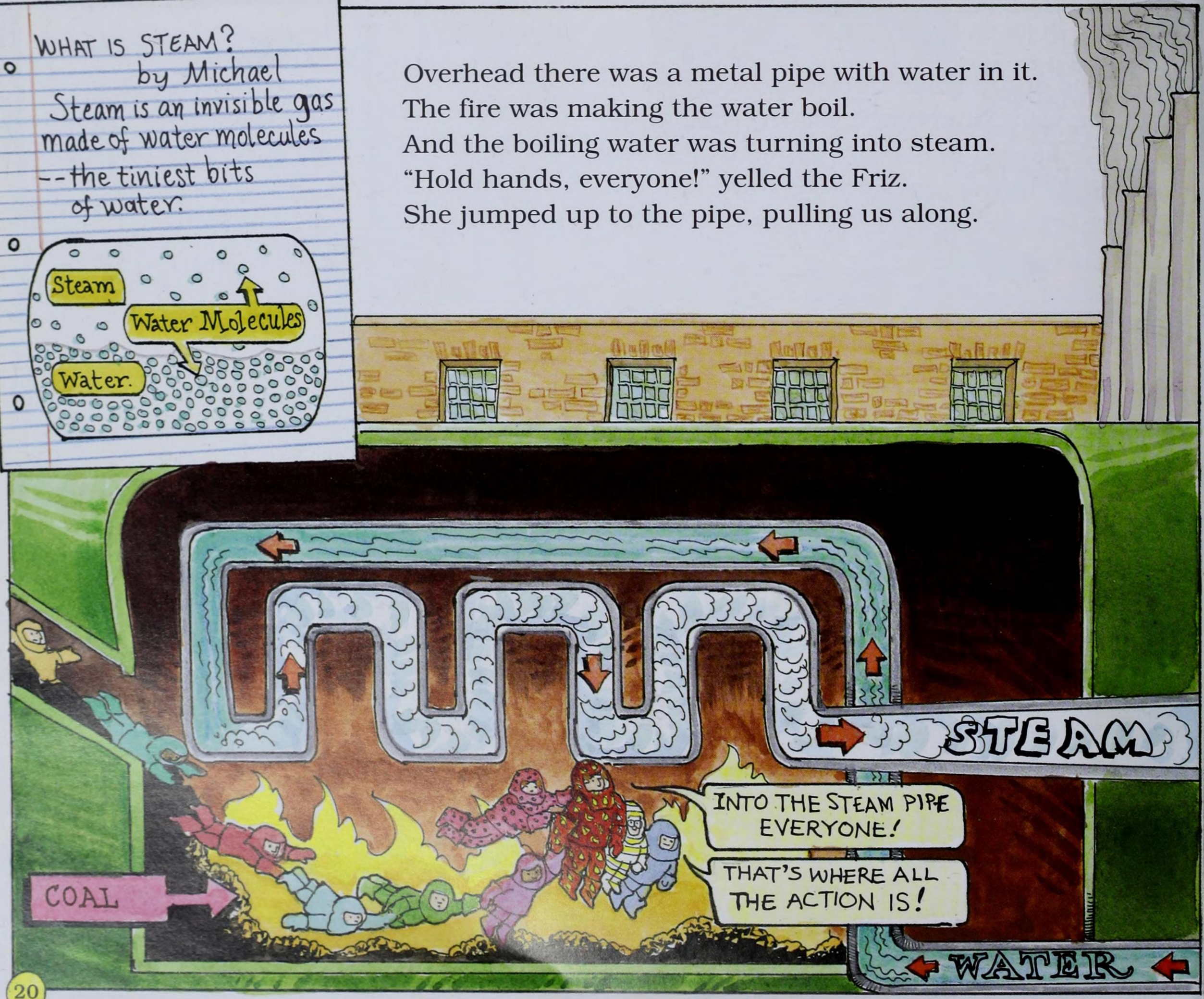

CLEANER WAYS TO MAKE ELECTRICITY
by Molly
Some plants can make electricity without fuel.
Solar Generators use the sun's energy.
Geothermal Plants use heat from inside the earth.
Hydroelectric Plants Use the energy of falling water.
Windmills use wind energy.
Tidal Plants use the energy of ocean tides.

THE BAD NEWS:
Right now we can't get all the power we need from these sources.

THE GOOD NEWS:
People can invent better ways to use nonpolluting sources.

WHAT IS STEAM?
by Michael
Steam is an invisible gas made of water molecules --the tiniest bits of water.

Overhead there was a metal pipe with water in it.
The fire was making the water boil.
And the boiling water was turning into steam.
"Hold hands, everyone!" yelled the Friz.
She jumped up to the pipe, pulling us along.



In a second, our whole class was inside the steam pipe. The steam was traveling at high speed — and we were, too. "Now we'll learn what all this steam is used for, class," called Ms. Frizzle. We steamed along through the pipe and into the next room in the power plant.

STEAM CAN DO WORK.
by Shirley
When steam is heated in a closed container it pushes out. We can use this pressure to do jobs for us.

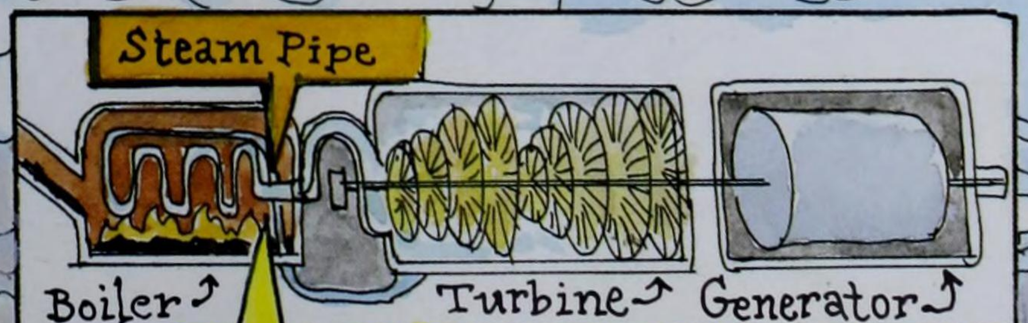
WA-HOO! FULL STEAM AHEAD!

THE STEAM IN THIS POT HAS "PUSH" POWER.

IT'S PUSHING UP THE LID.

THIS STEAM IS UNDER HIGH PRESSURE, CLASS.

I'VE NEVER BEEN COMFORTABLE IN HIGH-PRESSURE SITUATIONS.



Where we are in the power plant

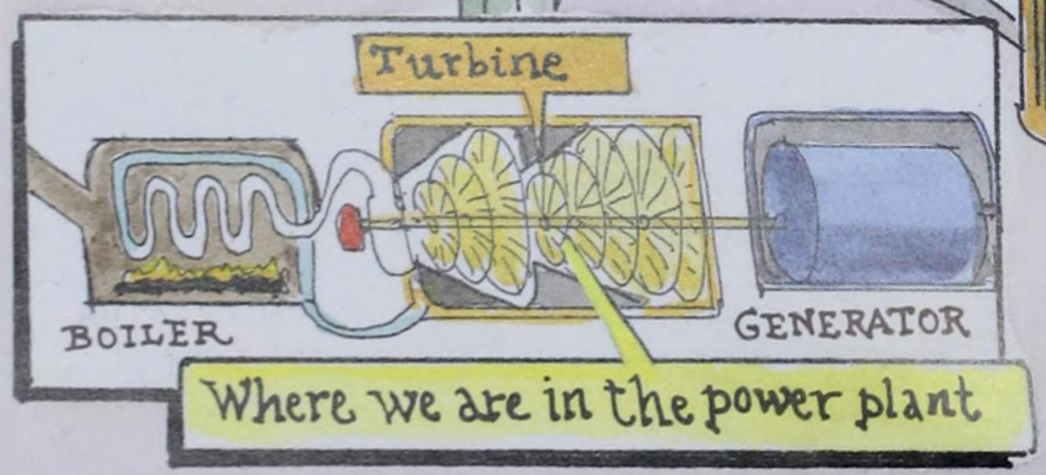
There was only one thing in the room —
an enormous machine called a turbine.
It had blades like a fan, and when the steam pushed
on the blades, the turbine spun around.

SUPER-HOT STEAM GOES FROM FURNACE TO TURBINE

SHAFT

TURBINE COMES FROM A WORD THAT MEANS "WHIRL" OR "SPIN."

SWISH



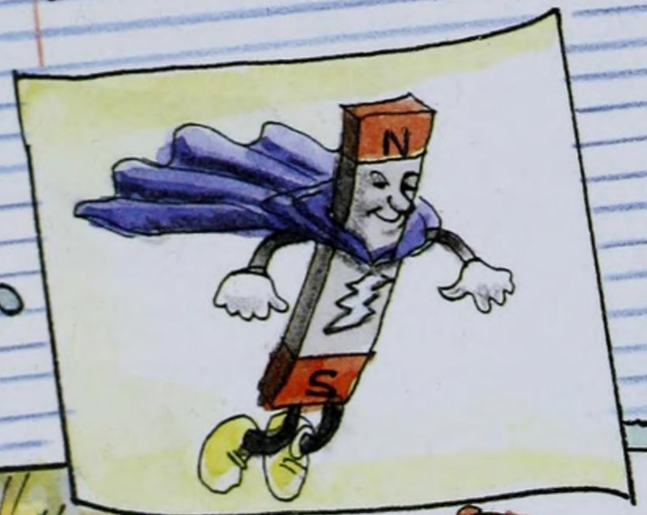
Where we are in the power plant

The turbine made a metal shaft spin, too. We spun around the shaft and slid along to the next part of the power plant. "Let's go look at what all this spinning is used for," said the Friz cheerfully. We were too dizzy to reply.

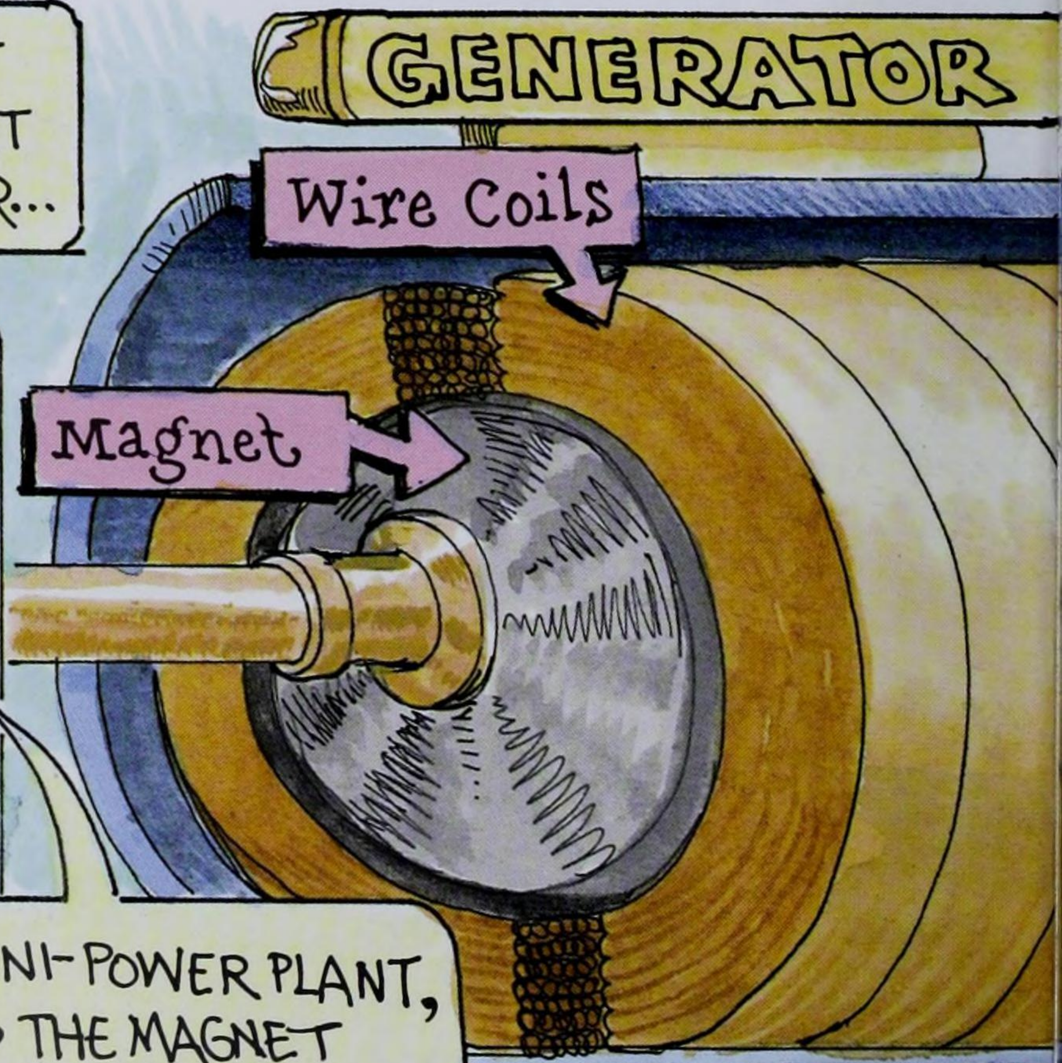
WHEEE

The shaft led us to the generator —
the part of the plant that actually makes electricity.
This generator was *really* big, but it worked just like
the little one we had made in school!
On the outside were coils of wire.
On the inside was a magnet.
The shaft turned the magnet, and the moving magnet
made electric current run in the wire.

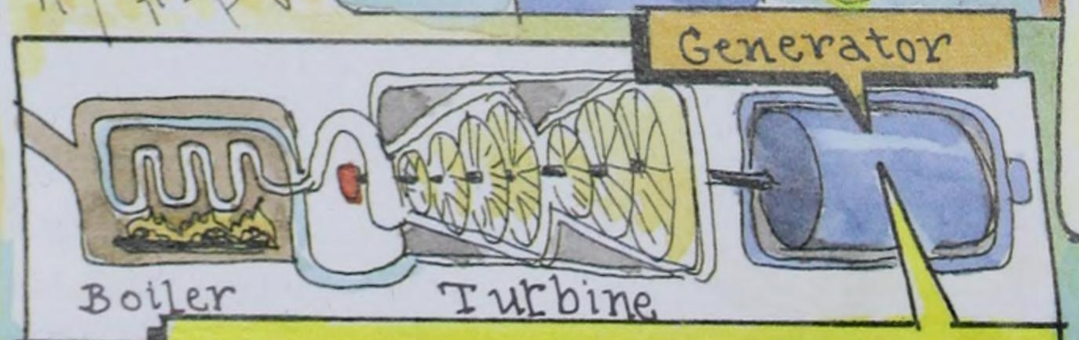
MARVELOUS MAGNETISM
by Phil
Almost all power plants use magnets. Without magnetism, we could not make large amounts of electricity.



THE POWER PLANT TURNS THE MAGNET WITH STEAM POWER...



IN OUR MINI-POWER PLANT, WE MOVED THE MAGNET WITH ARM POWER!



Where we are in the power plant

ELECTRIC OUTPUT

Then the current flowed into a power line
or large wire leading out of the plant.
"Next we'll observe what all this electricity is
used for," said the Friz.
Suddenly we began to get smaller...
and smaller... and smaller...
until we could fit inside the power line.

CLASS, WE ARE LEAVING THE POWER PLANT BY HIGH-VOLTAGE WIRE!

OOOH! I LOVE HIGH VOLTAGE!

I'VE ALWAYS THOUGHT OF MYSELF AS A LOW-VOLTAGE KIND OF PERSON...

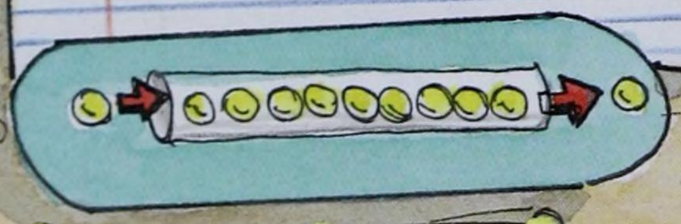
WHAT ARE VOLTS?
by Rachel
Volts measure the "push" of electric current.
The higher the voltage, the more pressure there is to push the current through the wire.

CURRENT LEAVES POWER PLANT AT 24,000 VOLTS

DOES EACH ELECTRON RUN THE WHOLE WAY FROM THE POWER PLANT TO YOUR HOUSE?

by Amanda Jane

NO! IT jumps only to the next atom. The process is a little like having a tube filled with a row of balls. If you put another ball in one end of the tube, each ball moves forward only one place. But the "current" flows all along the tube.



We got even smaller.
Now we could fit between the spaces in the wire.
Electrons were jumping all around us, making current.
We followed the Friz from the power plant through the lines toward our town, dodging electrons as we went.

LOOK AT ALL THE ELECTRONS IN HERE!

AND LOOK HOW FAST THEY'RE MOVING!

OOOH! I LOVE FAST!

NOT THIS FAST!

24,000 volts

Up to 345,000 volts

POWER PLANT

TRANSFORMER raises the voltage to help the current travel a long distance

Steel Transmission tower

On the way, we passed through transformers,
devices that made the voltage in the wire higher or lower.
Higher voltage helps the current travel the long distance
from the plant to the places that will use the electricity.
Lower voltages are used in factories and big businesses.
Still lower voltages are used in small buildings and homes.
"Where are we going?" someone asked.
"We're on our way to a lightbulb," the Friz answered calmly.

WHY IS MS. FRIZZLE TAKING US TO A LIGHTBULB?

BECAUSE SHE DOESN'T WANT TO GO TO A HEAVY BULB.

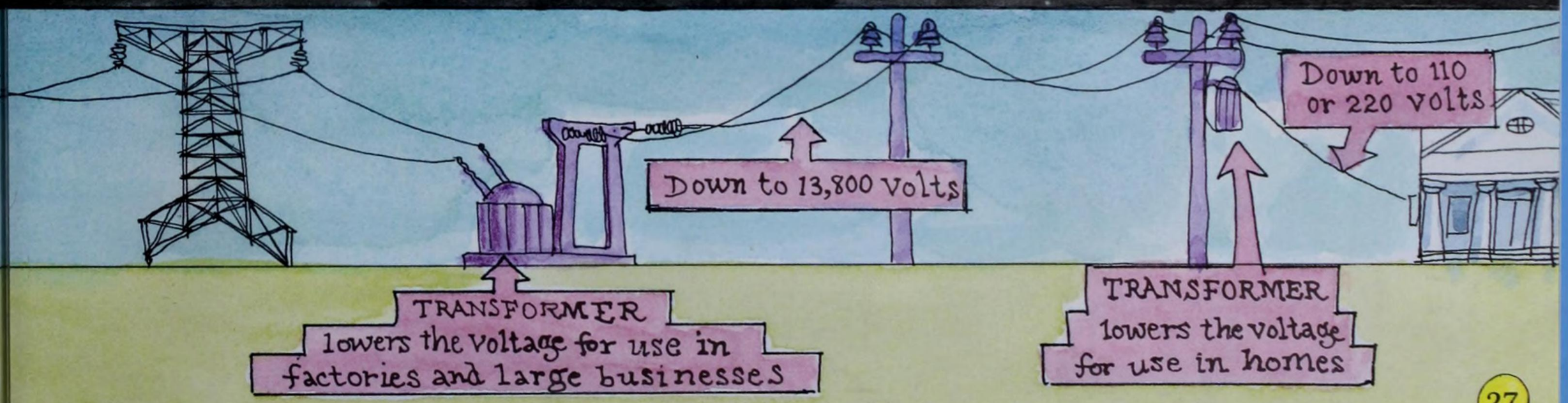
GET IT?

DO ELECTRONS RUN ONLY ONE WAY IN THE POWER LINE?
by Arnold

No! The electric current in the power line changes direction many times every second. This is called alternating current or "ac" for short.

A WORD FROM DOROTHY ANN

Transform means to "change."
A transformer changes the voltage from high to low, or from low to high.


Down to 13,800 volts
Down to 110 or 220 volts
TRANSFORMER
lowers the voltage for use in factories and large businesses
TRANSFORMER
lowers the voltage for use in homes

We were moving down the power line when
Ms. Frizzle said, "Here we are at the town library."
We followed her through the wires and into a lamp.
"We're going right into the lightbulb!" Wanda cried.
Inside the bulb, we squeezed into
a very, very, very thin wire — the filament.
"The filament makes the bulb light up," said Ms. Frizzle.

A WORD FROM DOROTHY ANN
Filament comes from a word that means "thread." The first filaments were made of burnt cotton thread or even bamboo.

First Bulbs

Cotton

Bamboo

Today's filaments are made of a strong metal called tungsten.

FILAMENT

CONNECTING WIRES

BASE

BULB

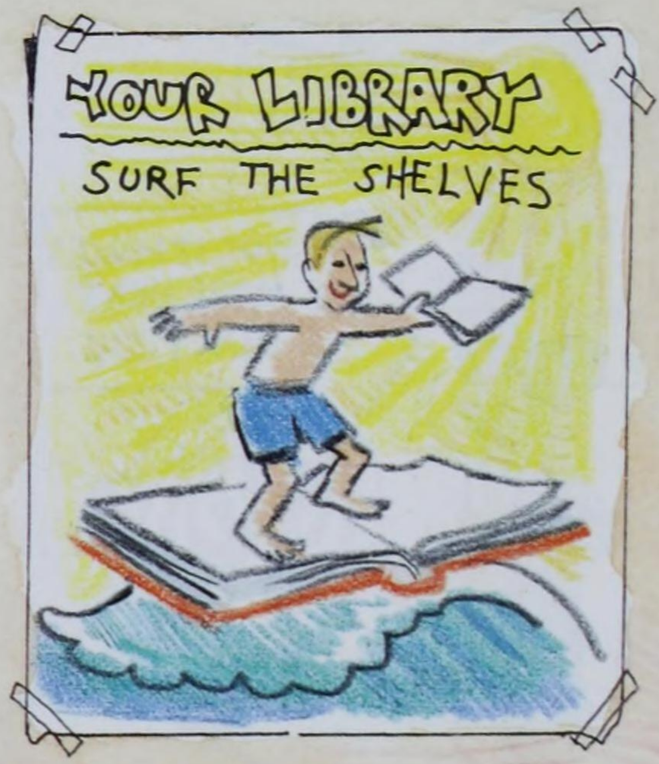
HEY, THERE'S MY MOM. SHE'S CHECKING OUT BOOKS FOR ME.

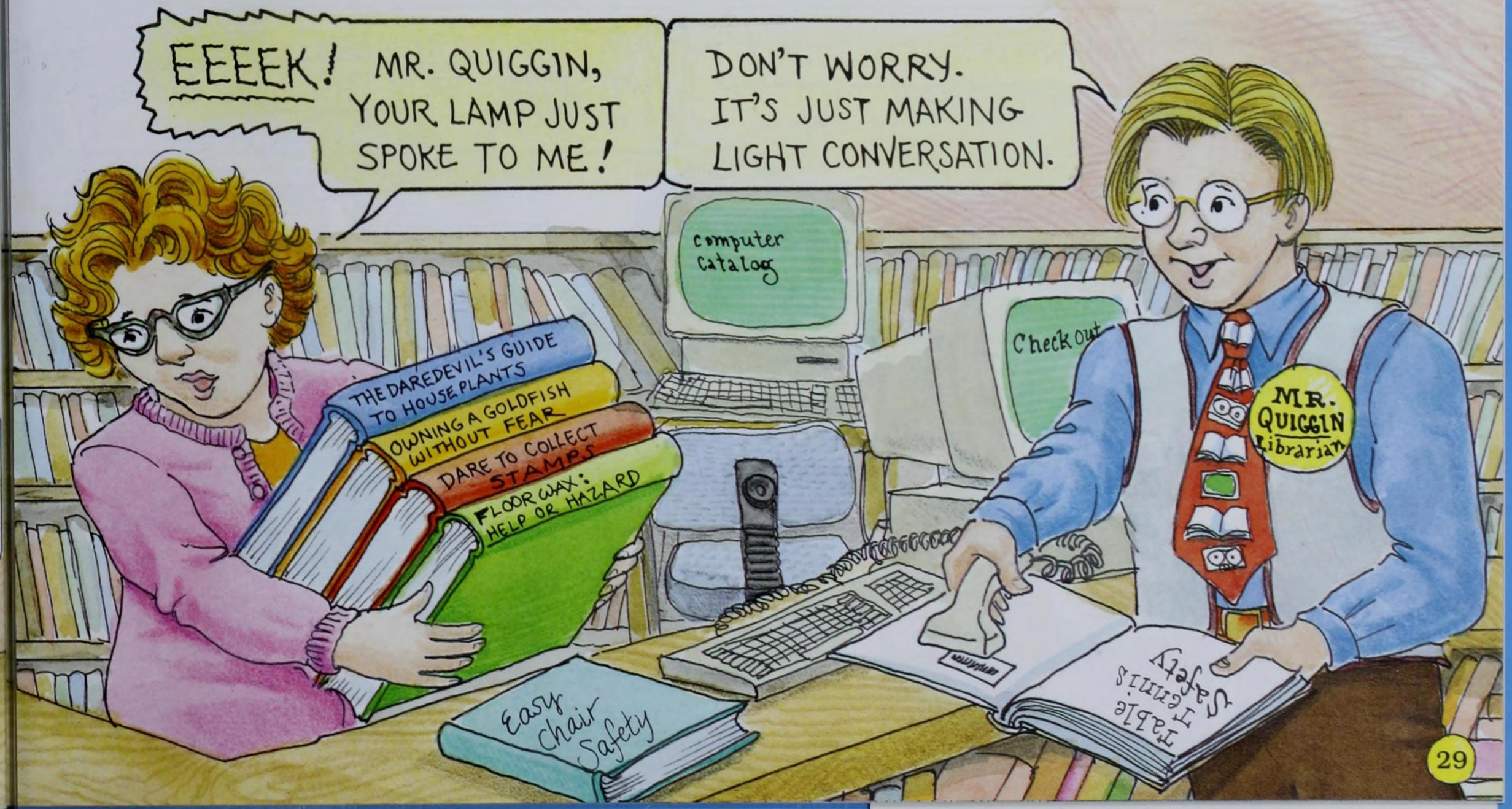
OOOH! THIS TINY FILAMENT MAKES A BIG LIGHT!

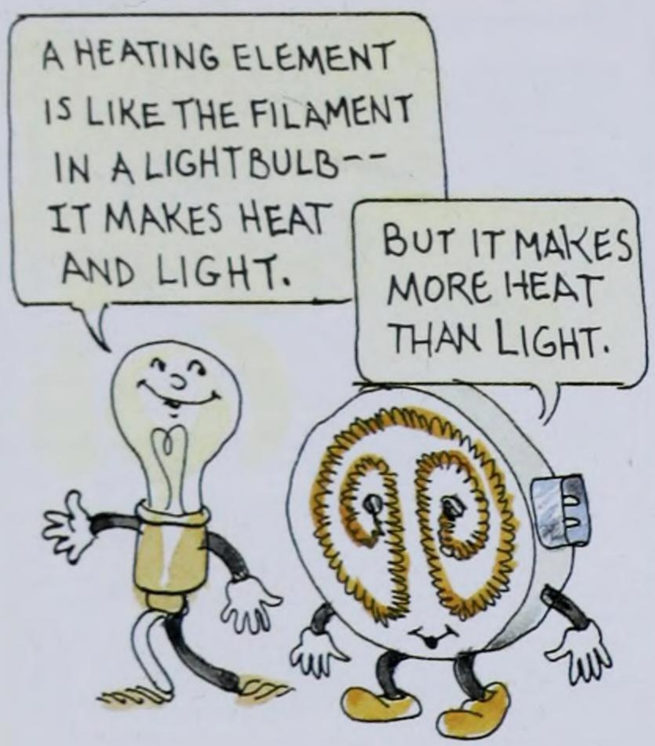
BE SMART! BE SAFE!

DON'T PUT YOUR FINGERS, YOUR TAIL, OR ANYTHING ELSE IN AN ELECTRIC OUTLET!

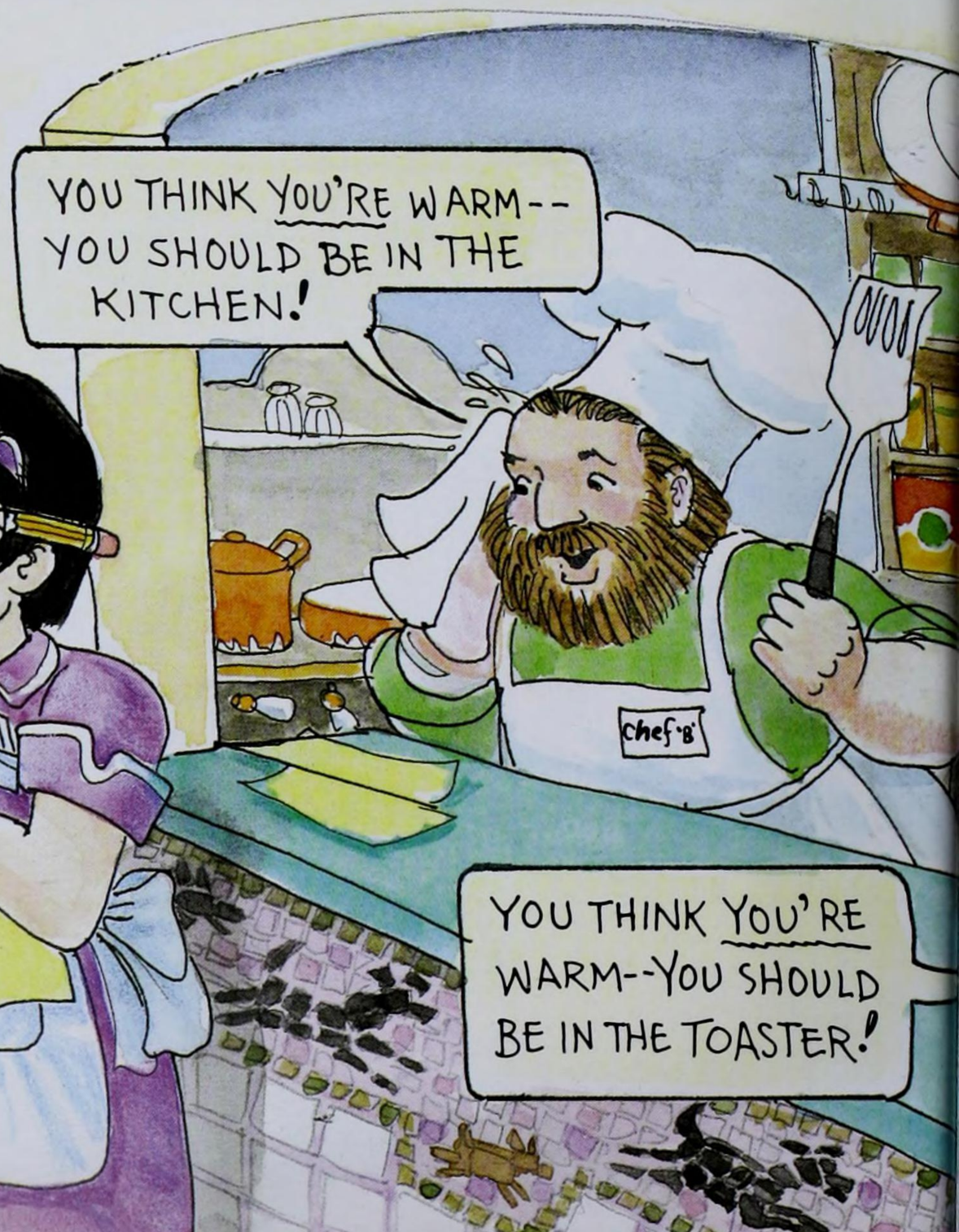
Billions and billions of electrons were pushing
through the thin filament all at once.
That made the filament get white hot.
When something is white hot, it glows with light.
We scarcely had time to put on our sunglasses
before we were in and out of the bulb.
Then we were heading away from the library.
We didn't even have a chance to check out any books!




EEEEK!
MR. QUIGGIN, YOUR LAMP JUST SPOKE TO ME!
DON'T WORRY. IT'S JUST MAKING LIGHT CONVERSATION.
computer catalog
Check out
THE DAREDEVIL'S GUIDE TO HOUSEPLANTS
OWNING A GOLDFISH WITHOUT FEAR
DARE TO COLLECT STAMPS
FLOOR WAX: HELP OR HAZARD
Easy Chair Safety
Table Tennis Safety
MR. QUIGGIN Librarian



We traveled down the street through the power line until we came to Jo's Diner.
Once inside the restaurant, we entered a toaster.
"Now we'll observe how electricity makes heat," said the Friz.
"Follow me into the heating element!"
The heating element was a coil made of a special kind of wire.
When electricity flowed through the wire, it got red hot!

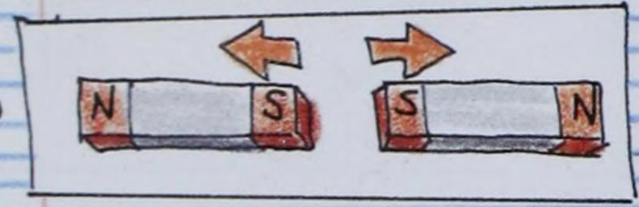


The heating element was making some toast.
That reminded us — wasn't it almost lunchtime?
Ms. Frizzle didn't stop. Maybe she wasn't hungry.
She went out the wire to the main power line again.
"We will now visit someone's house," she said,
making a sharp turn.
"I wonder whose house," murmured Phoebe.

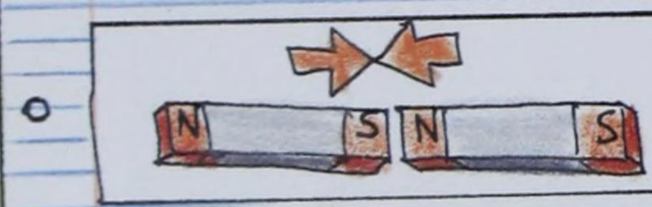
ONE TUNA SANDWICH ON TOAST, PLEASE!
MAKE THAT TWO!
TOO LATE--WE'RE GONE.
NOT EVEN FAST FOOD IS FAST ENOUGH FOR US!
IF AN ELECTRIC APPLIANCE MAKES HEAT, IT PROBABLY HAS A HEATING ELEMENT INSIDE.

HOW MAGNETIC POLES BEHAVE
by Wanda
Every magnet has two poles
-- north and south.

Poles that are the same
push each other apart.



Poles that are different
pull each other together.



It was Phoebe's house!
Her grandma was using a power saw
to make a bookcase for Phoebe's room.
"Oh good," said Ms. Frizzle. "This gives us a chance
to see how the saw is driven by an electric motor."
Ms. Frizzle said an electric motor has magnets inside.

I HOPE PHOEBE LIKES THIS.

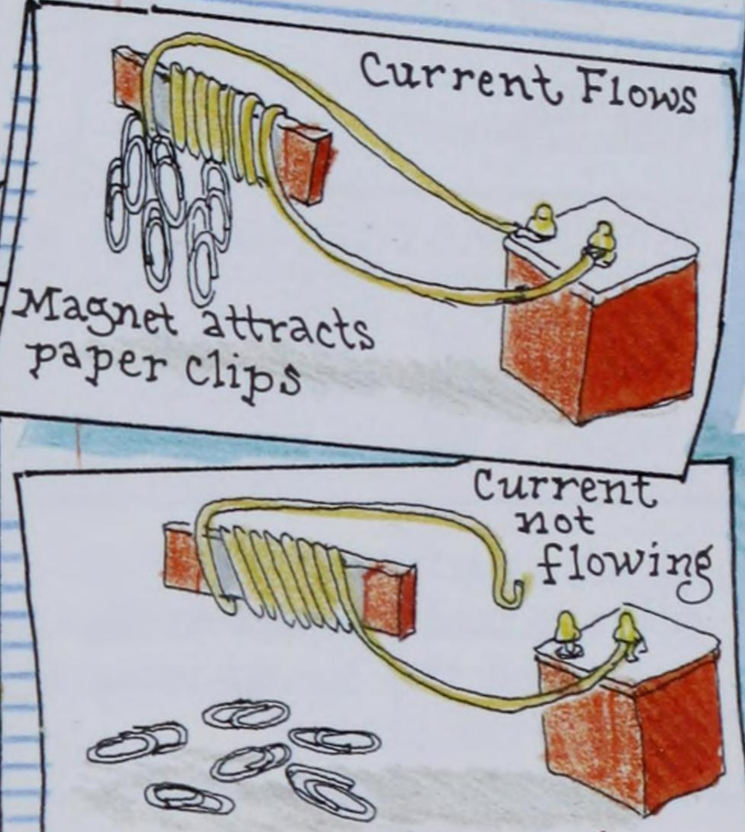
WELCOME HOME, PHOEBE.

AT MY OLD SCHOOL
I NEVER CAME HOME
IN THE MIDDLE OF
THE DAY.

"Remember how we made electric current with a magnet?" asked Frizzie. "Well, it works the other way, too. Electric current can turn a piece of metal into a magnet. This kind of magnet is called an electromagnet. Electromagnets are what make the motor run."

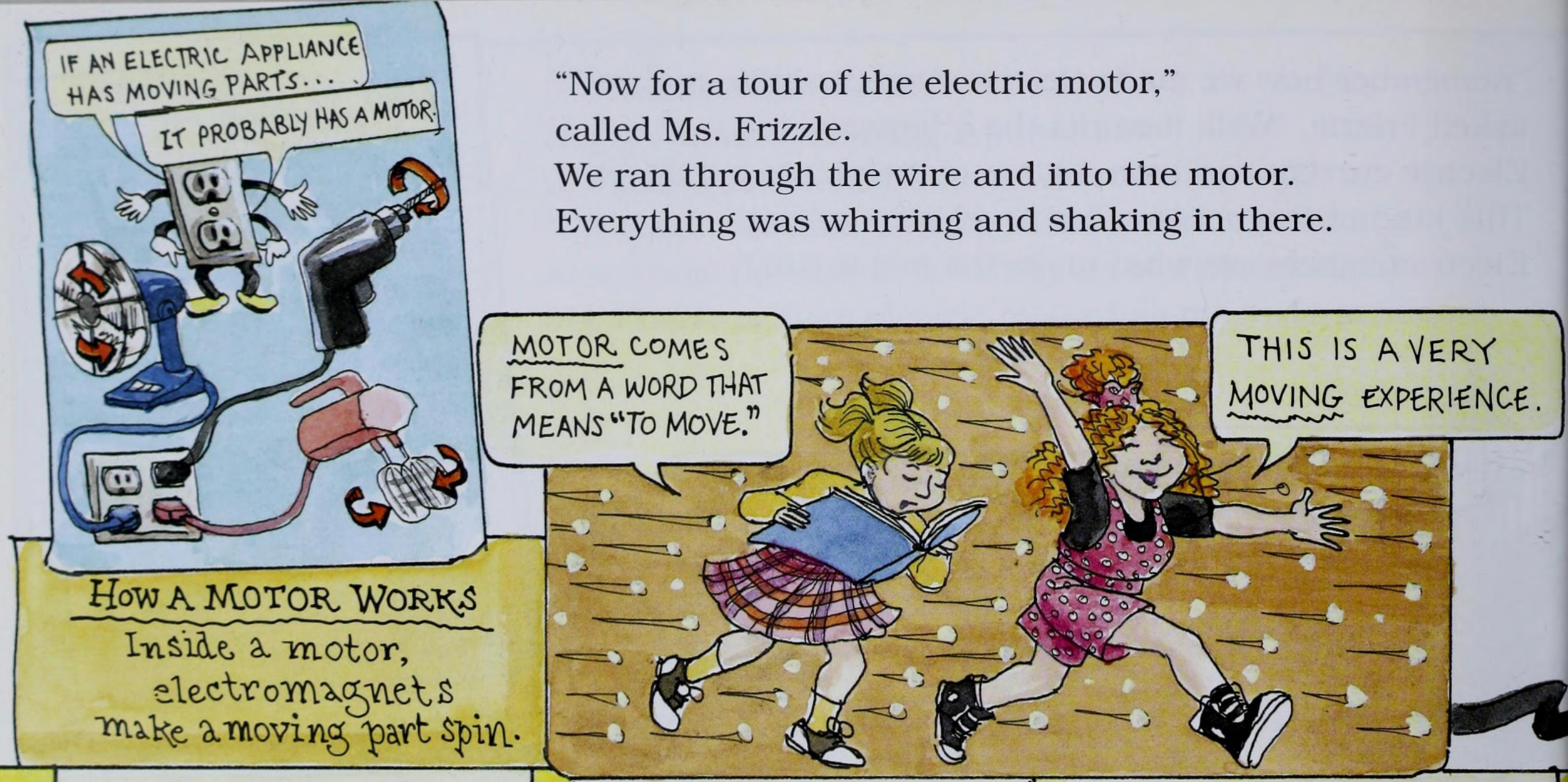
HOW TO MAKE AN ELECTROMAGNET
by Tim

A coil of wire is wrapped around a piece of iron or steel. When current flows through the wire, the metal acts like a magnet.



When the current stops the magnetism stops, too.

"Now for a tour of the electric motor,"
called Ms. Frizzle.
We ran through the wire and into the motor.
Everything was whirring and shaking in there.


IF AN ELECTRIC APPLIANCE HAS MOVING PARTS...
IT PROBABLY HAS A MOTOR.
MOTOR COMES FROM A WORD THAT MEANS "TO MOVE."
THIS IS A VERY MOVING EXPERIENCE.

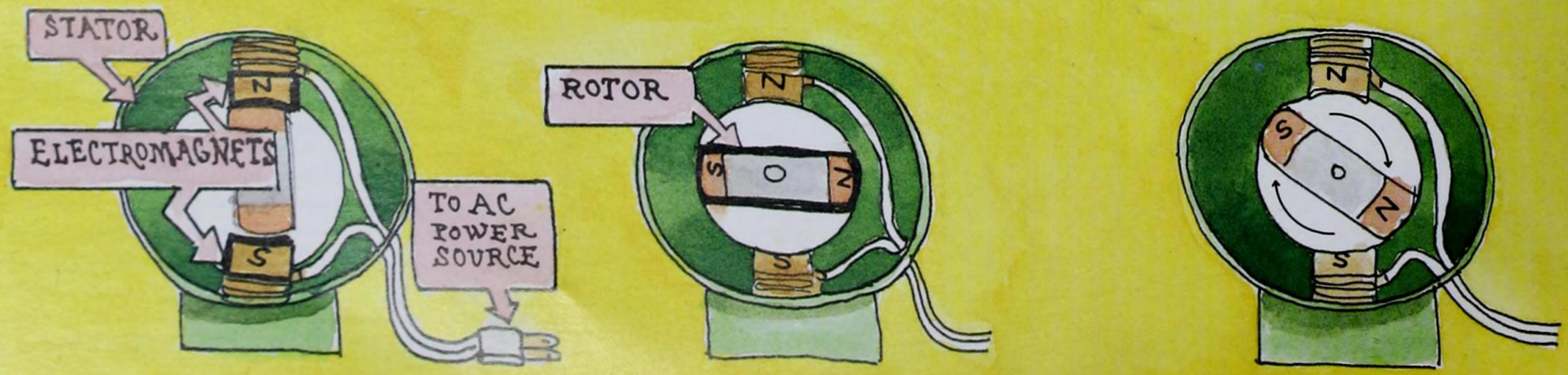
How a Motor Works

Inside a motor, electromagnets make a moving part spin.

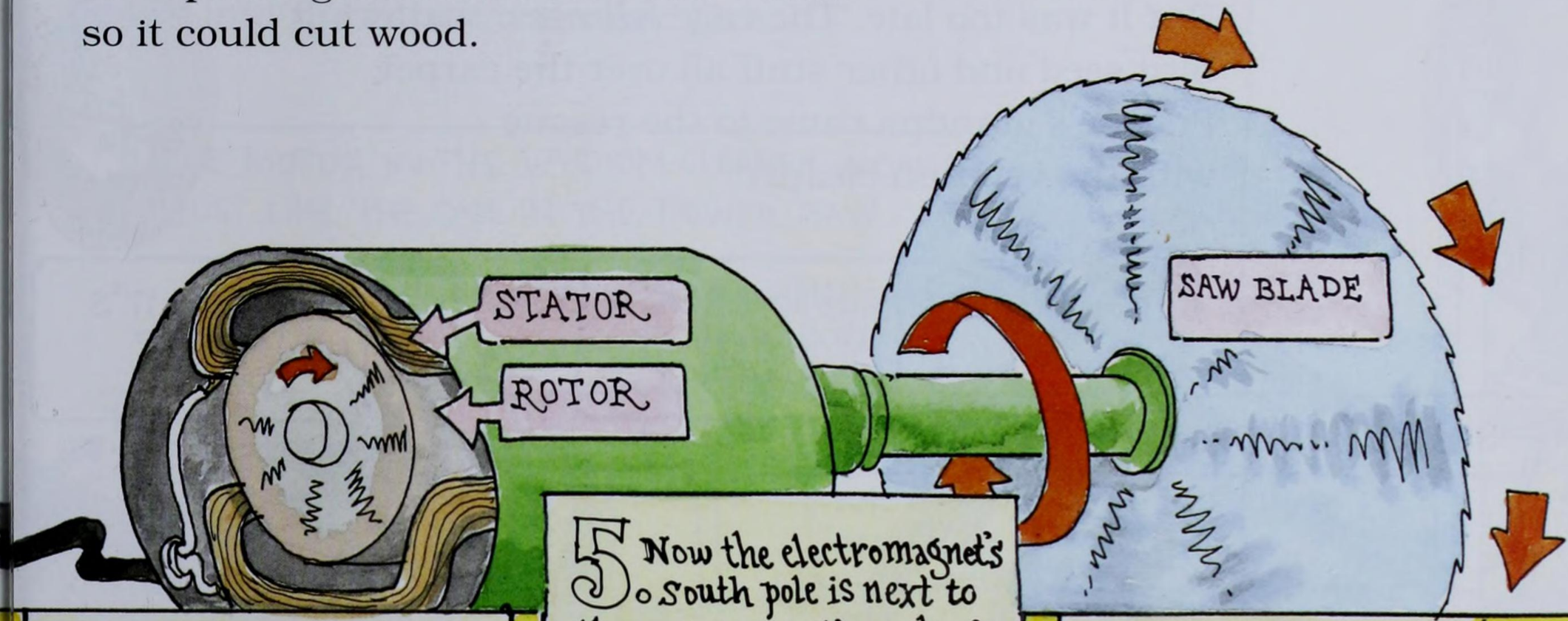
1. An electromagnet is attached to a part of the motor that does not move--the stator.

2. Another magnet is attached to a part that turns--a rotor.

3. The stator magnet's north pole pulls on the rotor magnet's south pole. This makes the rotor turn.



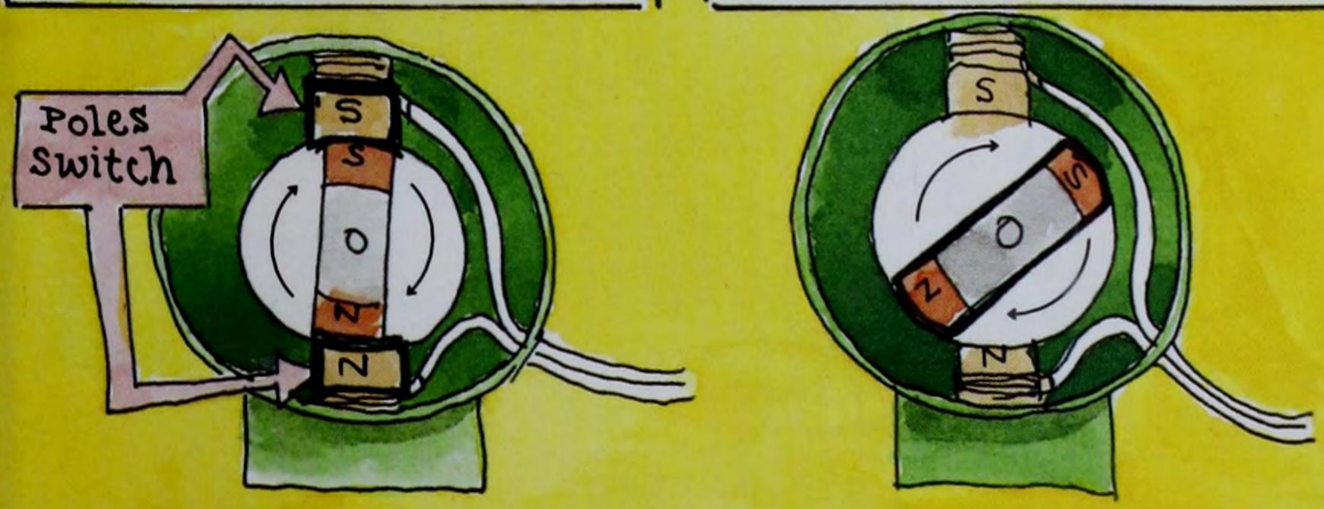
A cylinder called a rotor was turning very fast.
The rotor was attached to a shaft, and the shaft was attached to the saw blade.
The spinning rotor made the blade turn so it could cut wood.

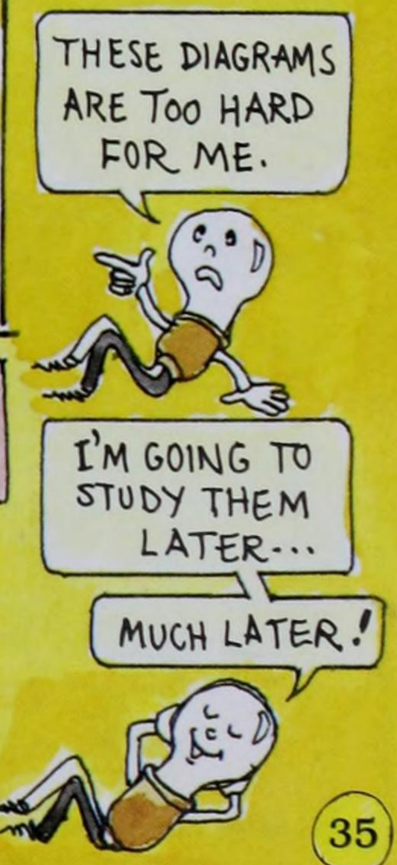


4. Then the alternating current in the wire coil changes direction. This makes the poles of the stator magnet switch places.

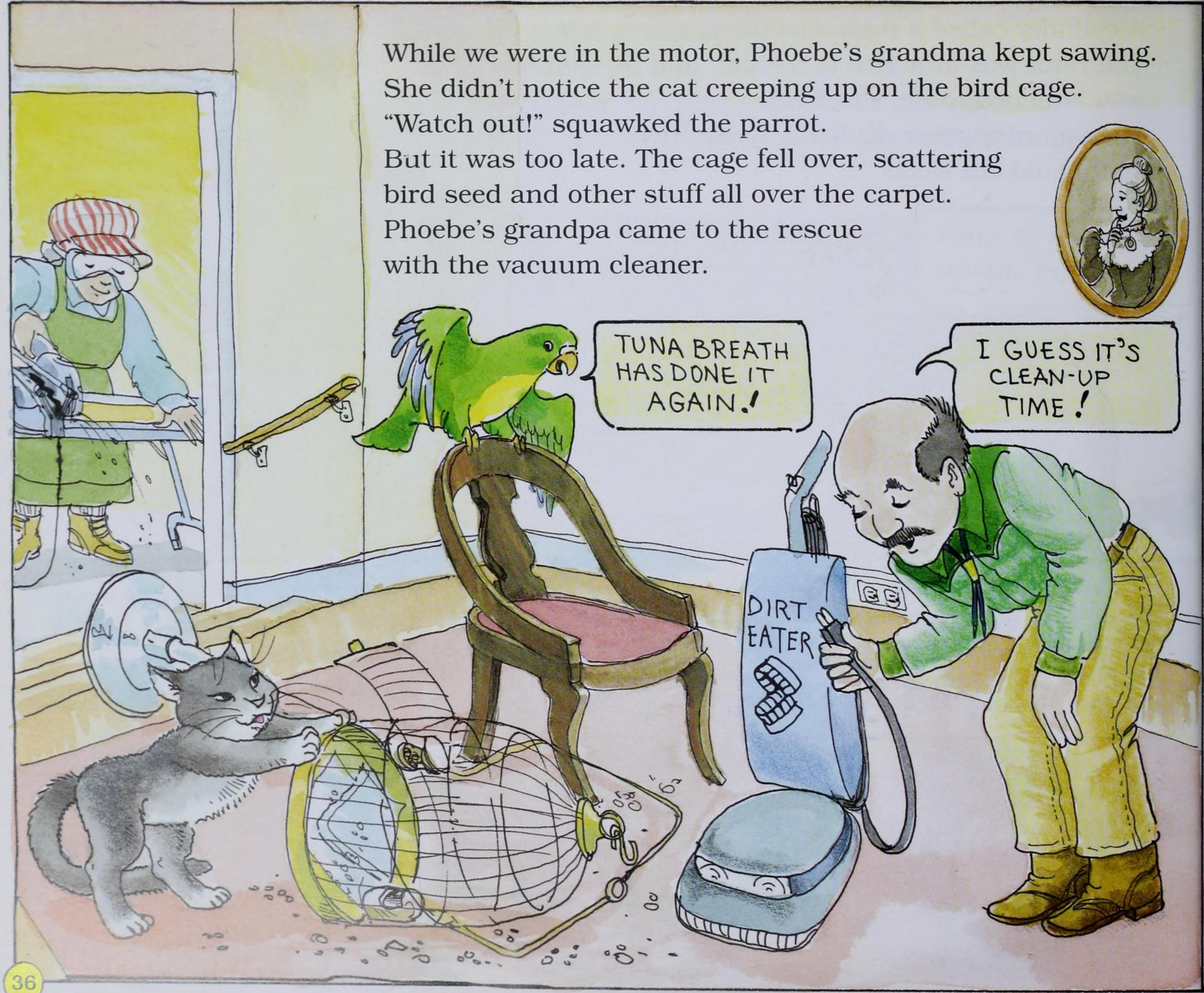
5. Now the electromagnet's south pole is next to the rotor magnet's south pole. These poles are the same, so they push each other away. This makes the rotor turn away from the electromagnet's south pole.

6. The current keeps alternating, so the rotor keeps turning.

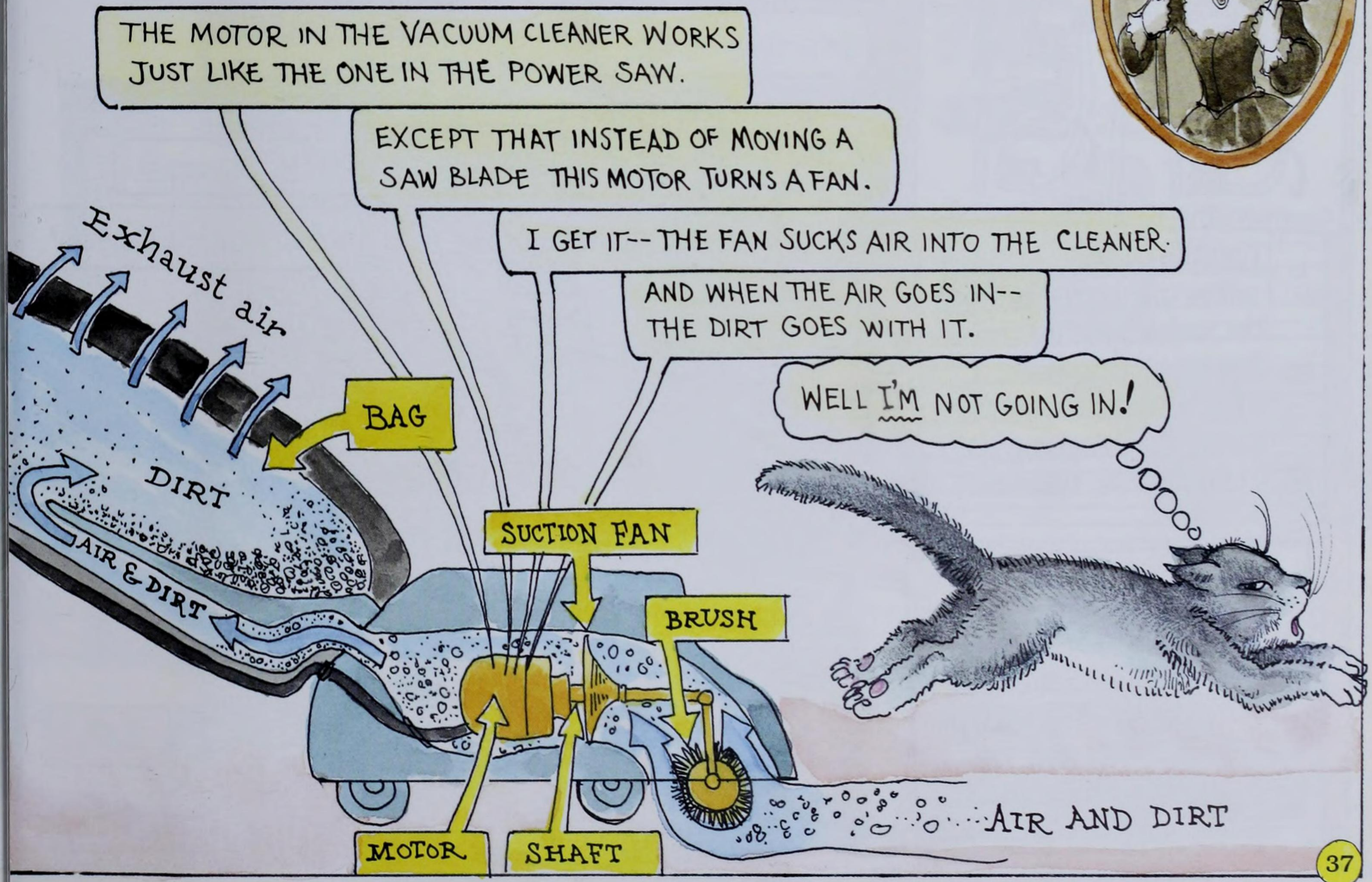




While we were in the motor, Phoebe's grandma kept sawing.
She didn't notice the cat creeping up on the bird cage.
"Watch out!" squawked the parrot.
But it was too late. The cage fell over, scattering
bird seed and other stuff all over the carpet.
Phoebe's grandpa came to the rescue
with the vacuum cleaner.

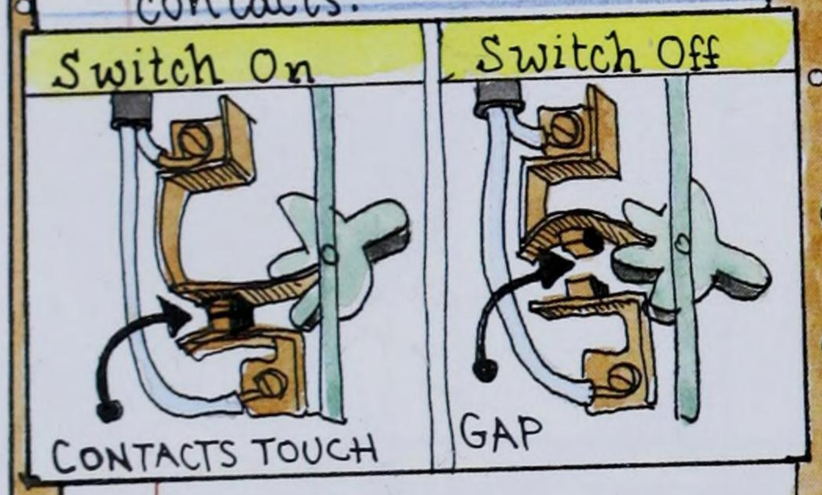


"Come on, kids!" called Ms. Frizzle. "We have to see this!"
She led us out of the power saw, in one outlet,
through the wires in the walls, out another outlet,
and into the vacuum cleaner wire.


THE MOTOR IN THE VACUUM CLEANER WORKS JUST LIKE THE ONE IN THE POWER SAW.
EXCEPT THAT INSTEAD OF MOVING A SAW BLADE THIS MOTOR TURNS A FAN.
I GET IT-- THE FAN SUCKS AIR INTO THE CLEANER.
AND WHEN THE AIR GOES IN-- THE DIRT GOES WITH IT.
WELL I'M NOT GOING IN!
Exhaust air
BAG
DIRT
AIR & DIRT
SUCTION FAN
BRUSH
MOTOR
SHAFT
AIR AND DIRT

How a Switch Works
by Alex

Inside the appliance, the wires are connected by two metal pieces called contacts.



Turning It On

When you switch to "ON," the switch pulls the contacts together. They make a little bridge between the wires. Then electrons can flow and the appliance works.

Turning It Off

When you switch to "OFF," the switch pulls the metal pieces apart. The electrons cannot flow, and the appliance shuts down.

We were getting ready to leave, when Grandpa finished vacuuming and turned off the switch. That made a gap in the electric pathway. No more electrons could flow past the gap, so the motor stopped running.

IT'S TIME TO GO.

FORGET IT--NO ONE IS GOING ANYWHERE.

NOT EVEN MS. FRIZZLE.

NOW THAT'S A SWITCH!

DOES A LIGHT SWITCH WORK LIKE THIS, TOO?

YES, ALL SWITCHES DO.

CONTACT

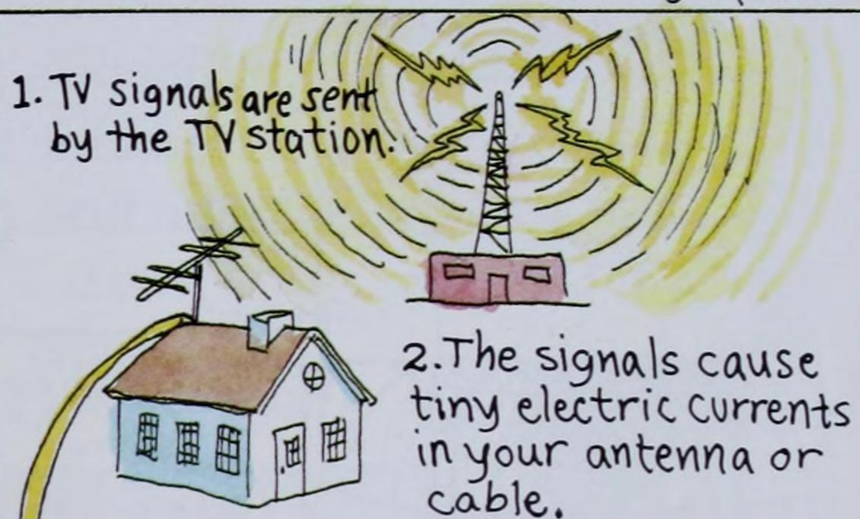
GAP

CONTACT

We called to Grandpa, but he couldn't hear us.
Phoebe was worried. She had to get back
in time for an after-school karate class.
The rest of us were playing in a soccer game.
But what could we do?
We were stuck in the switch of a vacuum cleaner!

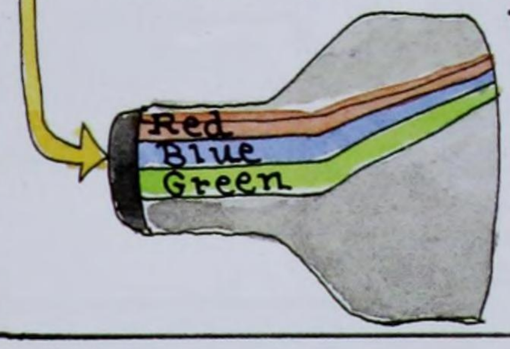
HOW YOUR TV WORKS by Keesha

1. TV signals are sent by the TV station.



2. The signals cause tiny electric currents in your antenna or cable.

3. The little currents control an electron gun in the picture tube in your TV.



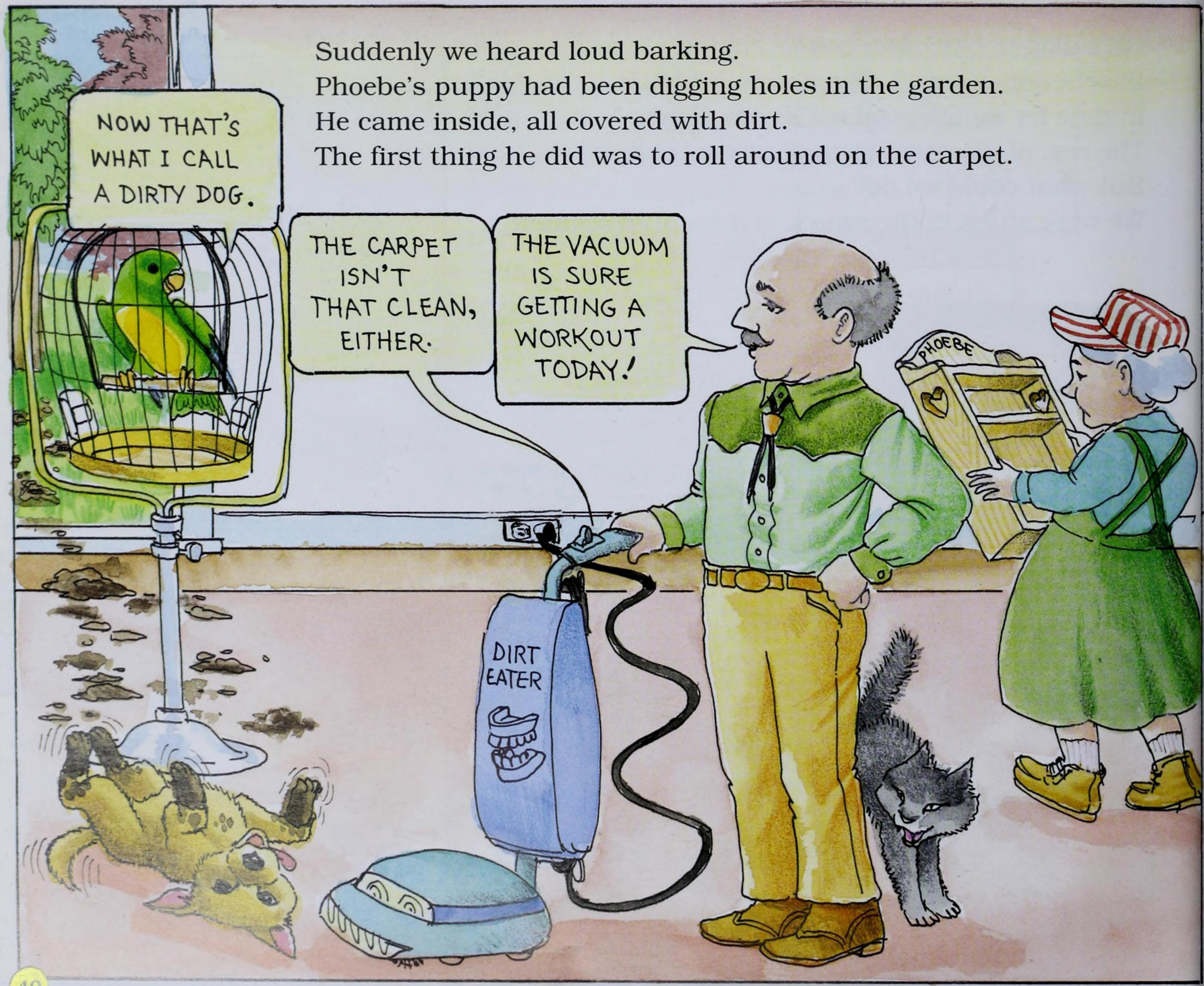
4. The electron gun shoots electrons at the back of your TV screen.

5. The screen is coated with thousands of dots made of phosphor -- a chemical.

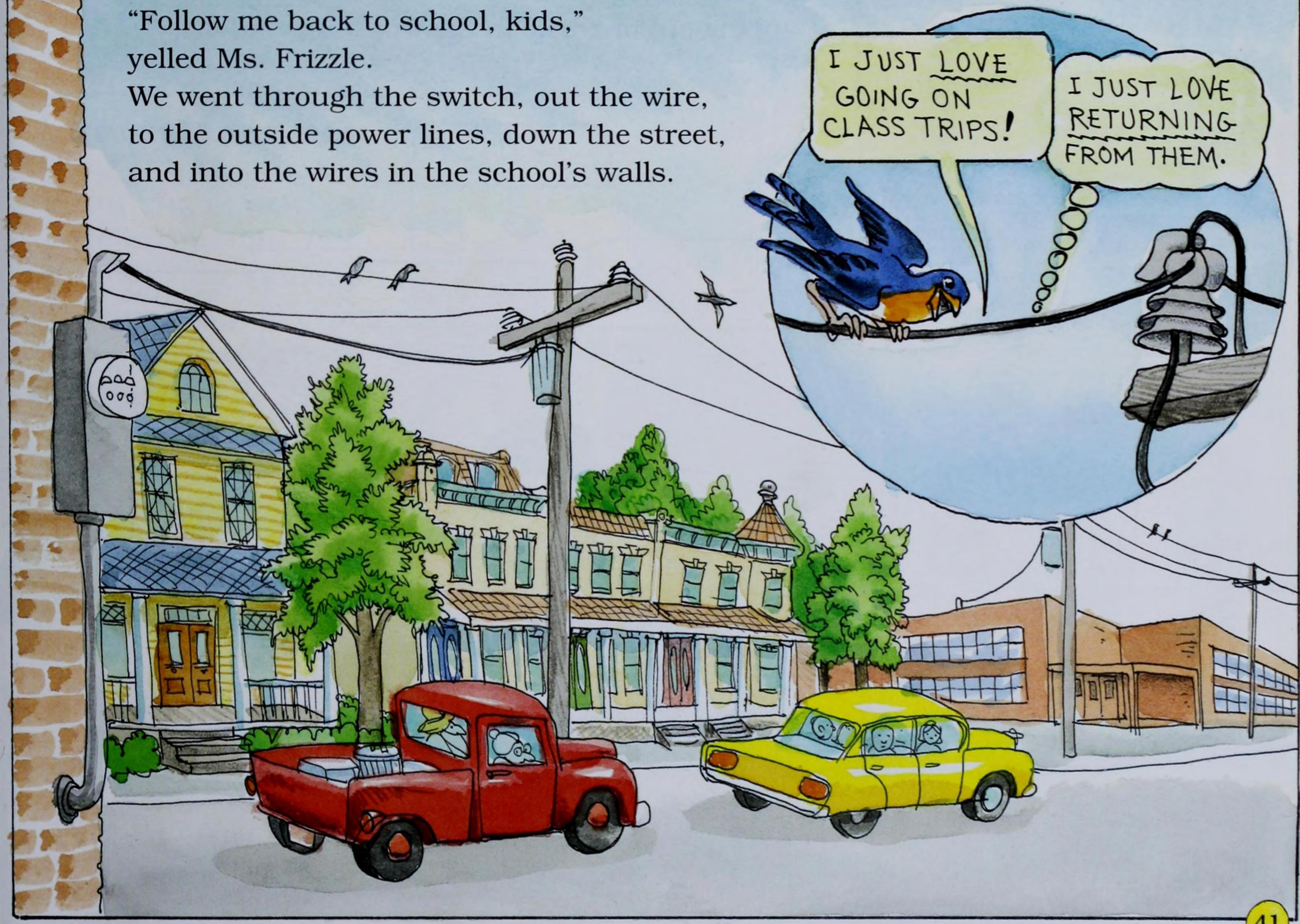
6. When electrons hit the phosphor dots, the dots glow with light.

7. The phosphor dots form shapes on the screen.

Suddenly we heard loud barking.
Phoebe's puppy had been digging holes in the garden.
He came inside, all covered with dirt.
The first thing he did was to roll around on the carpet.


NOW THAT'S WHAT I CALL A DIRTY DOG.
THE CARPET ISN'T THAT CLEAN, EITHER.
THE VACUUM IS SURE GETTING A WORKOUT TODAY!
PHOEBE
DIRT EATER

Grandpa had to switch on the vacuum cleaner again.
The switch pulled the contacts together,
and the electric path was complete again.
"Follow me back to school, kids,"
yelled Ms. Frizzle.
We went through the switch, out the wire,
to the outside power lines, down the street,
and into the wires in the school's walls.



We flowed through an outlet and into the wire of a floor waxing machine.
The next thing we knew we were popping out of a hole in the wire's insulation.

BE SMART BE SAFE
NEVER USE APPLIANCES WITH FRAYED, TORN, OR DAMAGED INSULATION.
HEY, I'M BIG AGAIN!
ME TOO!
THANK GOODNESS.
COME TO THE SCIENCE FAIR
YOU'LL GET A CHARGE OUT OF IT!

As soon as we had grown to our regular size,
Ms. Frizzle led us back to the classroom.

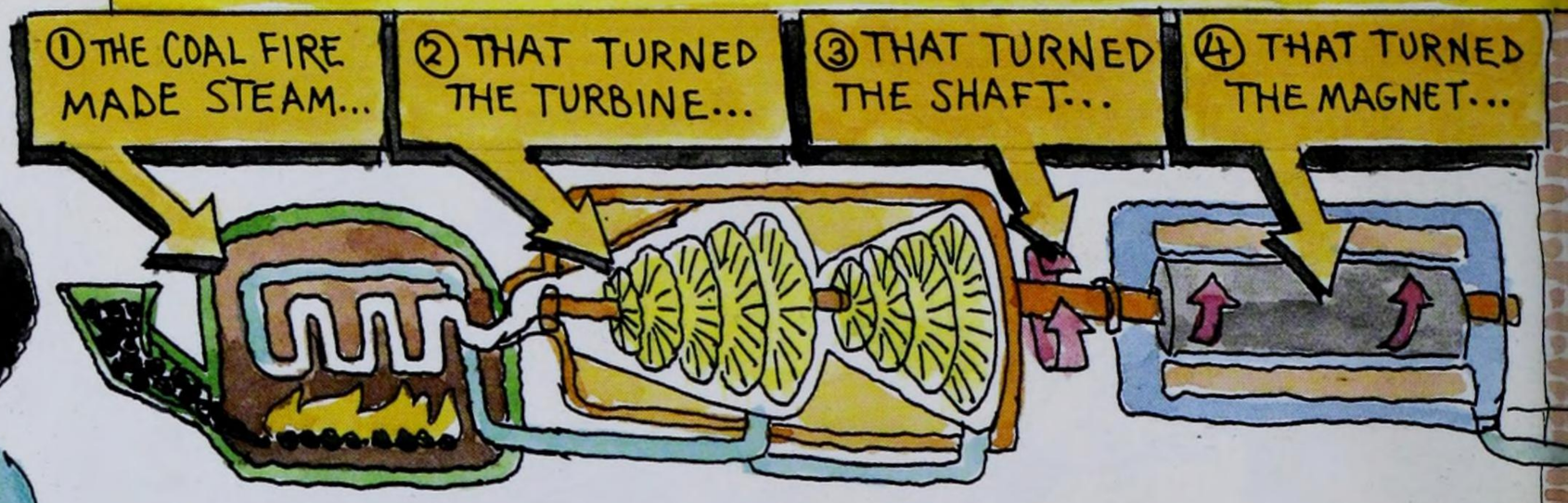
YOU'D BETTER REPAIR THE FRAYED INSULATION ON THE POWER CORD, MR. JOHNSON. YOU MIGHT BE SHOCKED!
REALLY?
CUSTODIAN'S OFFICE
Mr. Johnson
FRAYED SO!
JOHNSON

It had been *some* day!
We'd gone through fires and wires.
We'd had close encounters with subatomic particles.
And we'd seen a new side of home appliances — the inside.

I'LL BE RUNNING ALONG NOW. THANKS FOR THE TRIP. IT WAS ELECTRIFYING!

SO LONG DOTTIE. COME AGAIN.

OUR VISIT TO THE ELECTRIC POWER



Now everything was back to normal in our class.
Well... everything except Ms. Frizzle, of course!

Tough Assignment—Due Tomorrow

HOW DO THESE ELECTRIC APPLIANCES WORK?

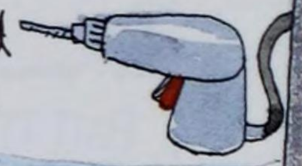
choose the correct answer

IRON

To make heat, it has:
a. a kitten
b. a heating element
c. wool socks

POWER DRILL

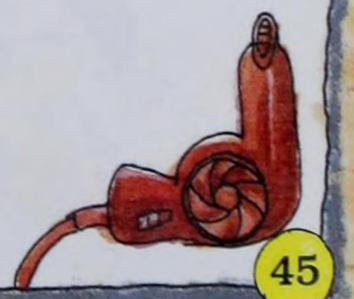
To move the drill bit, it has:
a. a motor
b. a rubber band
c. a rubber duck



HAIR DRYER

It makes heat and has a moving part--a fan to blow air--so it needs:

a. a heating element and a pickle
b. a pickle and a motor
c. a heating element and a motor.



GET REAL!

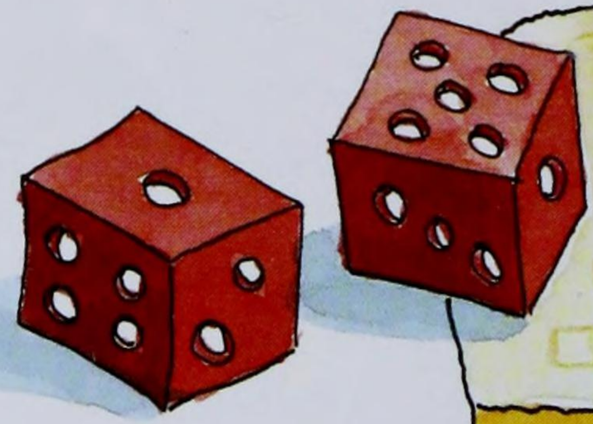
THE EXCITING NEW GAME THAT TELLS YOU WHAT'S REAL AND WHAT'S NOT!

SOME THINGS CAN HAPPEN ONLY IN OUR IMAGINATIONS

START

BUT IT DID HAPPEN.

IN YOUR DREAMS!



GET REAL!
SCHOOL CHILDREN CAN'T GO INSIDE THE FURNACE, TURBINE, OR GENERATOR AT A POWER PLANT.
GO BACK 2 SPACES

GET REAL!
KIDS REALLY CAN'T GO INSIDE ELECTRIC POWER LINES AND WIRES.
GO BACK 4 SPACES

IT'S TRUE!
ATOMS REALLY DO HAVE ELECTRONS.
GO AHEAD 3 SPACES

GET REAL!
A SCHOOLBUS CAN'T REALLY TURN INTO A DUMP TRUCK.
GO BACK 2 SPACES

PUH-LEEZE! I CAN'T BELIEVE THAT.

GET REAL!
MAGNETISM AND ELECTRICITY CAN'T REALLY FALL IN LOVE.
GO BACK 2 SPACES

IT'S TRUE!
MS. FRIZZLE REALLY DOES HAVE A NIECE WHO IS A LOT LIKE HER.
GO DIRECTLY TO FINISH

THE FRIZ IS AN IMAGINARY CHARACTER.

SHE IS?!

IT'S TRUE!
ELECTRONS REALLY DO TRAVEL THROUGH WIRES TO GIVE US POWER.
GO AHEAD 3 SPACES

GET REAL!
KIDS CAN'T RUN IN THE SPACE BETWEEN ATOMS.
GO BACK 4 SPACES

FINISH
YOU WIN!

OTHER THINGS WE WANT TO LEARN ABOUT ELECTRICITY by Ms. Frizzle's Class

How do batteries store electricity? by Wanda

What safe experiments can we do with batteries? by Arnold

How do solar generators work? by Tim

What is static electricity? by Carlos

How do computers work? by Ralphie

How do fluorescent lights work? by Dorothy Ann

What do these electricity terms mean? WATT AC AMP DC OHM by Ralphie

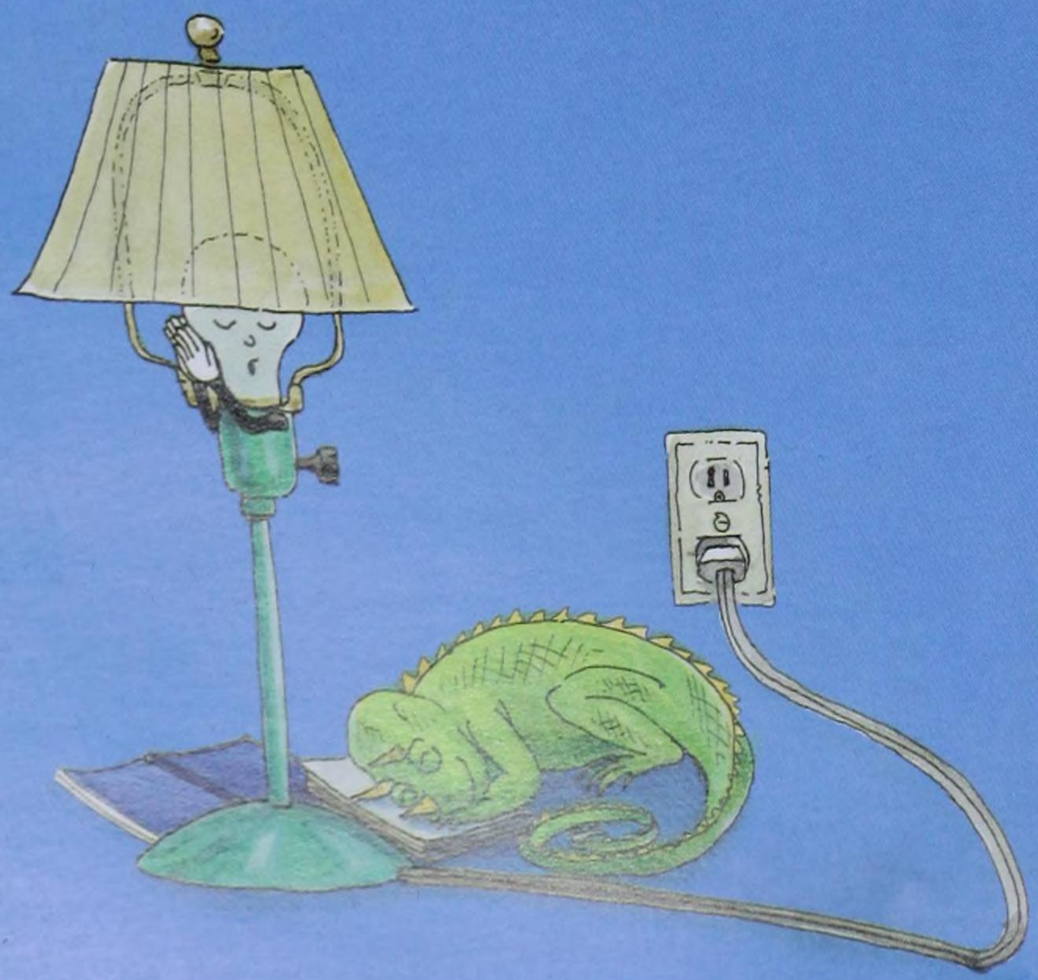
Is there electricity in my brain? by Phoebe

Why does water make electricity extra dangerous? by Keesha

Why should you never, never fly kites near a power line? by Rachel

MR. QUIGGIN Librarian

ANCIENT EGYPT

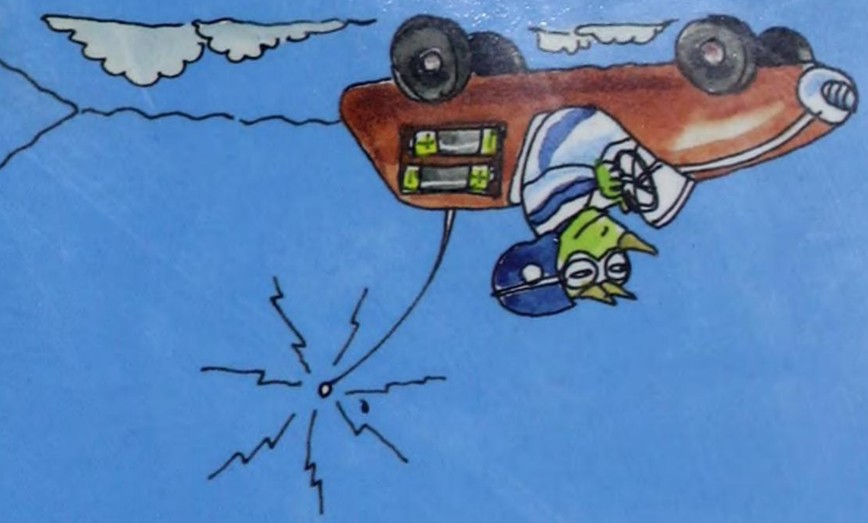


Joanna Cole and **Bruce Degen** bring their love of science and kid-like sense of fun to The Magic School Bus series. For this book, Joanna and Bruce went on their own electric field trips, touring a power plant and a line workers' repair station.

Writer Joanna Cole has received the *Washington Post*/Children's Book Guild Nonfiction Award and the David McCord Literature Citation for her significant contribution to excellence in the field of children's books. Artist Bruce Degen has illustrated more than thirty books for children, including *Jamberry*, which he also wrote, and the Jesse Bear series. They live with their families in the same small town in Connecticut.

Look for these Magic School Bus books:

The Magic School Bus AT THE WATERWORKS
The Magic School Bus INSIDE THE EARTH
The Magic School Bus INSIDE THE HUMAN BODY
The Magic School Bus LOST IN THE SOLAR SYSTEM
The Magic School Bus ON THE OCEAN FLOOR
The Magic School Bus IN THE TIME OF THE DINOSAURS
The Magic School Bus INSIDE A HURRICANE
The Magic School Bus INSIDE A BEEHIVE

Jacket art © 1997 by Bruce Degen

ISBN 0-590-44682-7
51595
EAN
9 780590 446822